Watercourse Assessment Report

Slippery Creek Catchment

[Month 2015] Technical Report [20xx/xxx]

Auckland Council
Technical Report [20xx/xxx]
ISSN 2230-4525 (Print)
ISSN 2230-4533 (Online)

ISBN xxx (Print)
ISBN xxx (PDF)

This report has been peer reviewed by the Peer Review Panel using the Panel's terms of reference
Submitted for review on xxx Review completed on xxx Reviewed by xx reviewers
[Optional Reviewed by: Name xxxxx | Position: xxxxx]
Approved for Auckland Council publication by: Name: xxx Position: xxx
Date: xxx

Recommended citation:
Ingley, R., Rieger, A., Magee, J., Reeves, E., Macintosh, K., Lowe, M., Young, D. (2016) Watercourse Assessment Report: Slippery Creek Catchment. Morphum Environmental for Auckland Council.
Auckland Council [technical report, TR20xx/xxx]

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Slippery Creek

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Morphum Environmental Ltd

Executive Summary

Watercourse Assessment Reports (WAR's) (previously called Watercourse Management Plans – WMP's) provide baseline information on the existing condition of waterways in both urban and rural settings. A WAR is a core resource in managing waterways to multiple objectives within realistic environmental, economic and social constraints. WAR's aim to provide information that can be used to maintain high value streams and enhance degraded streams while recognising the future growth pressures facing the Auckland Region and the essential function of urban streams in conveying stormwater.

The purpose of a Watercourse Assessment is to collect and report on meaningful data (engineering assets, biological and geomorphological stream state) in order to inform effective management of:

- Stream ecological health;
- Stormwater infrastructure; and,
- Stormwater conveyance.

Morphum Environmental Ltd was engaged by Auckland Council in March 2015 to undertake a detailed assessment of the watercourses within the Slippery Creek catchment. The watercourse assessment was conducted according to the Watercourse Assessment Methodology: Infrastructure and Ecology v 2.0 between April and September 2015. Watercourse physical variables were reflective of winter conditions with numerous rain events >5 mm occurring during this time. A total of 10 Stream Ecological Valuations (SEV's) were conducted in April 2015 at representative locations across the Slippery Creek catchment.

This report follows the WAR template. A literature review of local scale planning and historical reports are summarised in Section 2 of this report. Sections 3 and 4 summarise the results from the watercourse assessment, and Stream Ecological Valuations (SEV's) respectively. Management Zones and Enhancement Opportunities are described and discussed within Section 5.

Currently, 50% of the Slippery Creek catchment is pastoral land, over 25% of the catchment is dominated by indigenous forest and a further 5% if in exotic forestry blocks (LCDB 4.0). Less than 15% of the total catchment is currently built up (LCDB 4.0) however under the proposed Auckland Unitary Plan (PAUP), this may double to up to 30% of the total catchment area.

Slippery Creek is drained by four main watercourses, Slippery Creek, Hays Stream, Waihoihoi Stream, and Symonds Stream. These discharge via Slippery Creek to the upper Pahurehure Inlet of the Manukau Harbour under the Southern Motorway over bridge.

Eleven key management zones were identified, dividing the catchment into areas with similar land use pressures and maintenance activities. These zones included:

- areas of high ecological area worthy of protection.
- industrial zones and areas of modified watercourses with general stormwater maintenance works.
- areas of current development at Special Housing Areas and major parks works.
- areas of pine plantations.
- areas of rural lifestyle and pastoral farming.

The lower reaches of Hays Stream, Symonds Stream, and Waihoihoi Stream present the greatest scope for enhancement. The area west of the Drury fault line is currently predominantly comprised of mixed rural land use (dominated by pastoral land use), however, this area is zoned 'Future Urban' under the Proposed Auckland Unitary Plan which will require the development of a structure plan to facilitate future subdivision.

An opportunity exists to implement 'greenways' design concepts to develop riparian corridors that offer alternative transport connections and informal recreational space. This would help to address one of the six key goals of the Papakura Local Board; for Papakura to be a well-connected area that is easy to move around. Physical works will also be required to stabilise channel morphology to manage existing erosion issues and improve resilience to pressure from increased impervious surface cover. Currently no Stormwater Management Area - Flow (SMAF) zoning rules are in place in this area.

The Slippery Creek sub-catchment is predicted to be the greatest contributor of sediments to the Pahurehure Inlet and one of the second greatest contributors of heavy metal contaminants (Green, 2008). Reducing erosion and sediment discharge is therefore a key priority for the Slippery Creek catchment. Many of the key goals and objectives identified below aim to reduce erosion and contaminant issues in addition to other ecological, community, and conveyance outcomes.

Key goals and objectives for the catchments identified across the eleven management zones include:

- Establish 40 m wide riparian corridors with a minimum width of 10 m on each bank on the main channels of Symonds Stream and Waihoihoi Stream, and tributary 5 of Waihoihoi Stream.
- Future proof channels through erosion protection works.
- Upgrade and install all required inlets and outlets to appropriate inlet outlet standards including: TR2013-18 (Hydraulic Energy Management Inlet Outlet Design for Treatment devices); GD2015/004 (Water Sensitive Design for Stormwater); SWCoP 2015 (Auckland Council Stormwater Code of Practice for Land Development and Subdivision).

- Incorporate shared cycle/walkways along riparian corridors to improve connectivity to key recreational and transport infrastructure such as the Opaheke Sports Park and the Papakura Park and Ride.
- Manage willows to reduce erosion from flow diversion, debris jams, and improve fish passage to upstream high value habitat.
- Engage landowners to fence watercourses where moderate to severe stock damage has occurred to reduce further damage and ongoing sediment and faecal pollution downstream.
- Implement Sustainable Neighbourhoods or Water Sensitive Neighbourhoods Programmes to encourage guardianship of streams in public land.
- Provide education regarding management of waterways, landowner responsibilities, and supporting programmes and funding such as the Environment Initiatives Fund, or Trees for Survival.
- Ensure forestry activities are undertaken with best management practices with a particular emphasis on management of sedimentation.
- Improve resilience of remnant and regenerating indigenous forest by restoring connections between nearby fragments particularly along riparian corridors.
- Protect natural headwater and floodplain wetlands and springs.
- Investigate sources of heavy metal contamination.

Table 1: Summary of survey area and contributing catchment

Est. Length of Permanent and Intermittent Stream (m)	261,493 (estimated from OLFP with catchments >2ha)					
Length of Surveyed Stream (m)	87,179.3					
Catchment Area (km^2)	46.3					
Catchment Imperviousness	8.2%					
Receiving Environment	Pahurehure Inlet, Manukau Harbour					
Dominant Substrate	Silt/Sand					
Vegetation	**0 – 10 %**	**10-30%**	**30-50%**	**50-70%**	**70-90%**	**>90%**
Average Overhead Cover (% of total stream length)	8.7%	13%	15.3%	24.9%	28.5%	9.5%
	Natural			**Artificial**		
Wetlands	68			75		
Erosion	**Excellent**		**Good**	**Fair**		**Poor**
Overall Upper Bank Stability Index (% of total stream length)	0.4%		40.5%	53.8%		5.3%
	Percentage of the No. of reaches with >60% erosion scarring			**Total No. Erosion hotspots**		
	2.9%			33		
Engineered Assets	**Total No.**		**Poor-Very Poor Condition**	**Incorrect in GIS**		**Not Safe Drops >1.5m with easy public access**
Inlets, Outlets, and Culverts	1,067		33	19		3
Bank and Channel Lining (total length (m))	1,0017.5		58	na		3
Fish	**No. of species observed**		**Percentage of fish points with suitable habitat**		**Percentage of the No. of reaches with suitable habitat**	
	5		0.3% (instream or bank)		8.3% (instream or bank)	
Potential Barriers to Fish Passage	**Swimmers**		**Climbers**		**Anguiliforms**	
Natural Structures	131		35		5	
Engineered Structures	104		66		16	

Table of Contents

List of Figures

List of Tables

1.0 Introduction

1.1 Scope

The objective of this project was to obtain a Watercourse Assessment Report (WAR) and geodatabase that will provide a framework for prioritised management of the watercourses in the Slippery Creek catchment.

The scope of this project is described as follows and detailed in Table 2:

- Undertake a Watercourse Assessment and prepare a Watercourse Assessment Report (WAR) for the Slippery Creek catchment, including associated maps and completed geodatabase.
- All services must be undertaken in accordance with the Watercourse Assessment Methodology: Infrastructure and Ecology Document (Version 2.0).
- The length of stream identified within the scoping map must be surveyed.
- Ten (10) Stream Ecological Valuations (SEV's) are to be undertaken within the catchment. The location of the SEV"s will be selected in consultation with Auckland Council and following Appendix B Ancillary in the Watercourse Assessment Methodology.

The stream survey was conducted in accordance with the Watercourse Assessment Methodology: Infrastructure and Ecology (Version 2.0) which replaces the former Auckland Council Specification for Stream Assessment Surveys and Watercourse Management Plans. The Watercourse Assessment Methodology (WAM) provides a template document for the WAR which replaces the previous Technical Reports and Watercourse Management Plans.

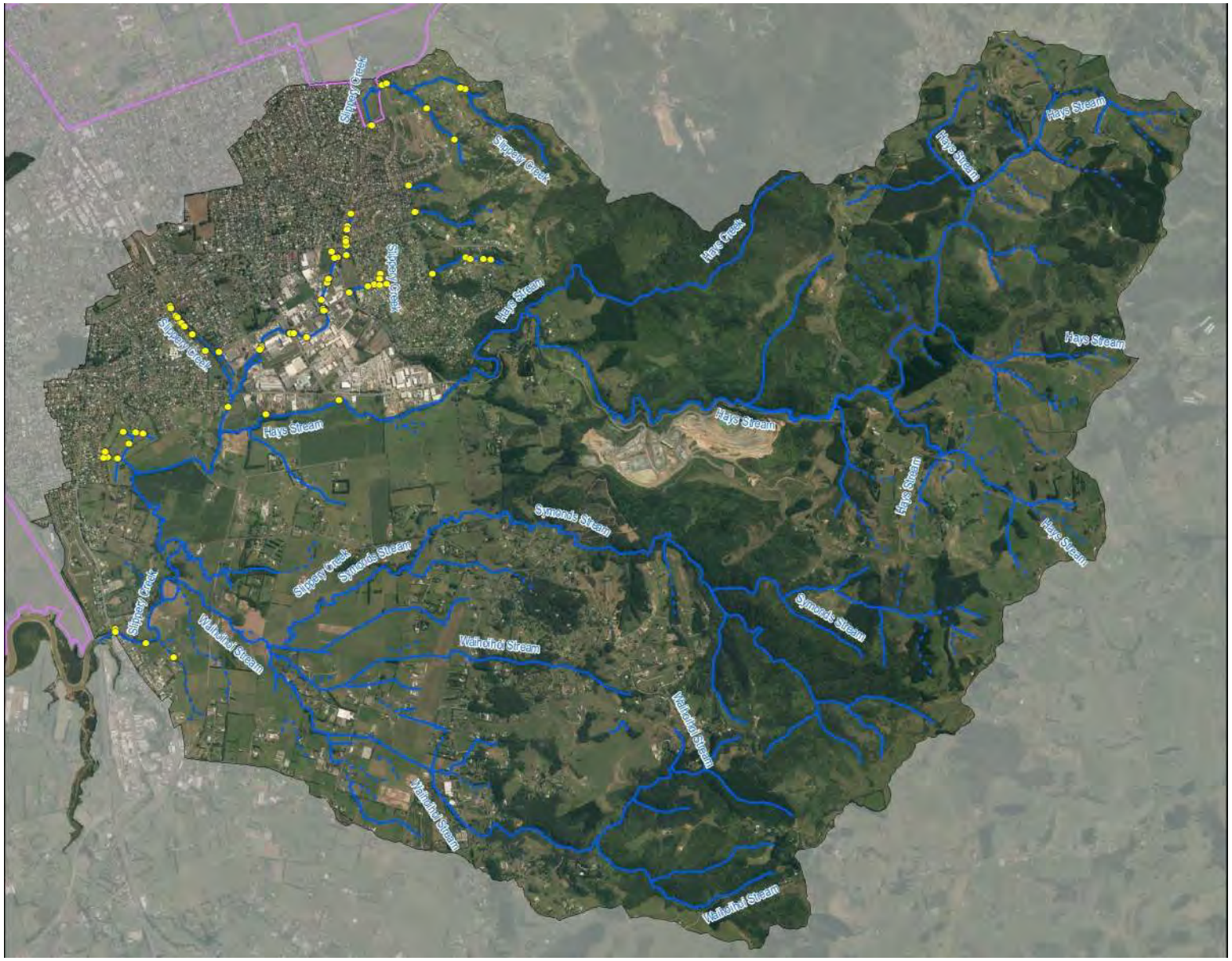


Figure 1: Streams to be surveyed as part of the project scope (shown in blue with public outfalls in yellow).

Table 2: Watercourse Assessment scope matrix

Watercourse Management Plan Component Protocol	Urban Environment	Rural Environment
Pre-survey Desktop Assessment		
Literature Review	Yes	Yes
Field Stream Assessment		
Reach Assessment (Ecoline)	Yes	Yes
Natural Structures	Yes	Yes
Fish Survey	Yes	Yes
Stream Mouths	Yes	Yes
Inanga Spawning	Yes	Yes
Wetlands	Yes	Yes
Asset Inspection (Inlets / Outlets)	Yes	Yes*
Asset Inspection (Culverts / Pipes)	Yes	Yes*
Bank and Channel Lining	Yes	Yes
Erosion Hotspots	Yes	Yes
Enhancement Opportunities	Yes	Yes
Miscellaneous Points	Yes	Yes
Post-survey Desktop Assessment		
Management Zones	Yes	Yes
Stream Ecological Valuations (SEVS)		
SEV's	Yes	Yes
Electrofishing	Yes	Yes
Clarity Measurements	Yes	Yes
Sediment Chemistry and *E. Coli*	Yes	Yes

* Where required by the methodology

1.2 How to use this document

1.2.1 Overview

The Watercourse Assessment Report document summarises comprehensive data collected during the field stream survey and additional Stream Ecological Valuations (SEV's) conducted at representative reaches throughout the survey area. The document relies on tables and maps to provide concise information to guide selection of management actions.

This document consists of a literature review (Section 2.0), summary of field survey findings (Section 3.0), SEV results (Section 4.0), and watercourse management (Section 5.0) including Management Zones, Enhancement Opportunities and Maintenance Activities. These sections are supported by a map series provided in the appendices, which should be referred to whilst reading the body of the Watercourse Assessment Report. The geodatabase provided should be used for further analysis and interrogation.

Refer to the Watercourse Assessment Methodology document (Lowe *et al.* 2014) for information regarding survey methodologies and data collected during the field survey as well as information on the background and objectives of the Watercourse Assessment process and relevant policies and plans. Figure 2 provides a guide to the Watercourse Assessment structure.

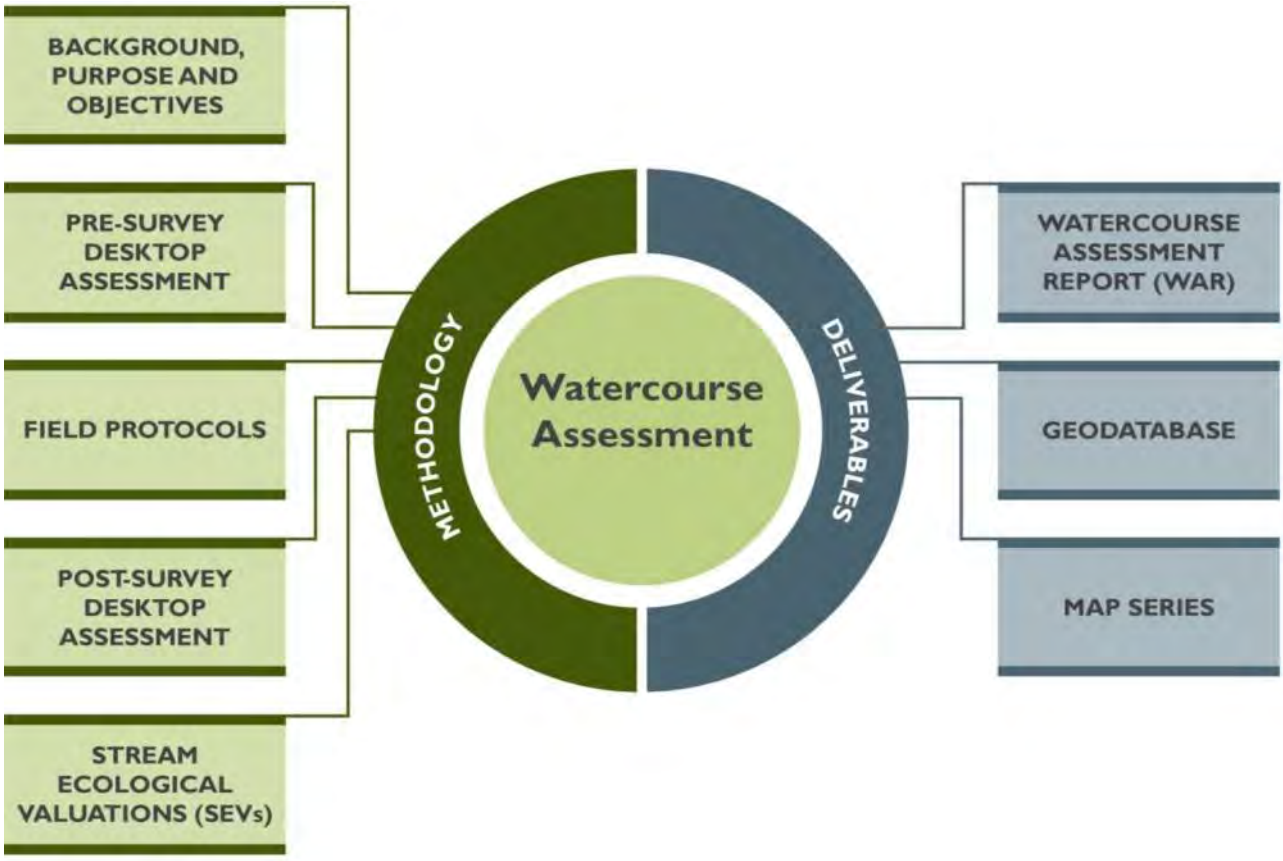


Figure 2: Watercourse Assessment structure

1.2.2 Limitations

1.2.2.1 Identified Options

Auckland Council is not obligated to undertake any works identified as enhancement or management options in a WAR, nor is Auckland Council bound by preliminary prioritisation of projects undertaken as part of this methodology. Recommendations made will be considered within the context of Auckland Councils obligations, constraints, drivers, project identification, and catchment prioritisation undertaken or identified by Auckland Council.

1.2.2.2 Stream Classification

The Watercourse Assessment provides an unofficial field estimate of stream classification only and this classification is not specifically intended for Resource Consent purposes. Although specific and detailed assessment is required prior to consent approval for any works within a subject reach, the details contained in this document can be used to guide associated investigations for a resource consent application. Failure to identify a stream reach during this Watercourse Assessment process does not suggest that a stream does not exist or that any such stream is ephemeral.

1.2.2.3 Temporal limitations

Watercourse Assessment undertaken as per this methodology must be considered within the seasonal context. Variables such as water depth and velocity are dependent on the level of base flow, and antecedent conditions such as stormwater inflows prior to the assessment. Time since last rainfall event is recorded to guide interpretation. Factors that are more variable over diurnal time scales such as temperature are not recorded as part of this assessment as time series data is required for meaningful results.

1.2.2.4 Assessment Methodology

It is acknowledged that the Watercourse Assessment Methodology is largely a visual assessment of engineering assets as well as biological and geomorphological stream state. Parameters are also typically averaged over the extent of each reach and there will be some variability along this length.

Where possible, definitions and procedures detailed in more intensive quantitative or semi quantitative standard methods have been used to inform parameters included in the WAM.

2.0 Literature Review

2.1.1 Auckland Council District Plan – Operative Papakura Section 1999

The entirety of the Manukau Harbour is identified as a Significant Natural Heritage Area in the Auckland Regional Policy Statement. Associated policies require that District Plans include provisions to preserve and protect these areas. The Papakura District Plan therefore outlines rules and objectives to ensure that the subdivision, use, and development of land in the coastal environment of the district does not compromise the natural character, coastal processes, or conservation values of the area.

The Hays Creek Dam is a water supply dam that provides potable water for Papakura. The dam catchment is approximately 182 ha and the retention of high water quality within the dam catchment is identified as an important consideration for the wellbeing of Papakura District within the Papakura District Plan.

2.1.2 Auckland Council District Plan – Franklin

Franklin is a large district and includes the main urban areas of Pukekohe, Tuakau, and Waiuku as well as extensive rural areas. Only the uppermost reaches of Hays Stream fall within the Franklin District Plan boundaries.

2.1.3 Papakura and Franklin Local Board Plans 2014-2017

The Slippery Creek catchment falls across the boundaries of the Papakura and Franklin Local Board areas. The majority of the catchment lies within the Papakura Local Board area with only the western upper reaches of Hays Stream crossing into the Franklin Area.

The Papakura Local Board Plan identifies six key outcomes including the goal that Papakura will be well-connected and easy to move around. It is anticipated that a Greenways Plan for the South will be developed in the next few years however in the meantime the Board will continue to fund links between existing parks and along coastal esplanades. Another key outcome for Papakura is that the area will be treasured for its environment and heritage. To further this goal the Papakura Board will champion green drainage systems such as new wetlands with the ultimate goal of improving the health of Manukau Harbour and its catchment streams.

The 2015 local board discretionary operational budget has prioritised on-going clean up and replanting efforts along the Papakura Stream which lies outside of the Slippery Creek catchment area (Papakura Local Board, 2015).

The Franklin Local Board Plan identifies five key outcomes, the first of which is to have a cherished natural environment. Key objectives under this outcome include the

development of a greenways plan for the Franklin area and to investigate how to increase public access to waterways in the Hunua Ranges for recreational use.

Under the Auckland Council Long Term Plan, Papakura Local Board has identified the following priority projects that are relevant to this watercourse assessment report (Auckland Council, 2015):

- Development of a Papakura Town Centre master plan
- Development of Pahurehure Inlet cycle and walkways
- Continued development of the Opaheke Sportsfields

2.1.4 Integrated Catchment Management Plan

The Slippery Creek Integrated Catchment Management Plan was prepared in 2010 to provide a blue print for managing land uses, growth development, flood hazards, water quality, stream quality, receiving environment quality, and stormwater and wastewater networks. The Slippery Creek catchment covers the existing urban areas at the lower southern side of Papakura and Drury township including the stormwater catchment areas traditionally known as the Croskery Road Drain catchment, the Bellfield catchment, the Hays Stream catchment, and the Symonds and Waihoihoi Stream catchment.

Several stormwater projects identified in the Slippery Creek catchment ICMP have not yet been completed and these have been summarised in Enhancement Opportunities 2 and 8 in section 5.2.

Key stormwater management strategies identified for the catchment included:

- Undertaking a catchment management study in an integrated and systematic manner to assess the effects of future developments in the catchment area and identity a range of remedial options.
- Incorporating low-impact development measures in new development to reduce stormwater runoff and enhance the amenity in the urban areas if practicable.
- Protection of the stream riparian margin and minimise infilling of 1% AEP flood plain.
- Protection or provision of significant secondary overland flowpaths in existing and new urban development.
- Implementing remedial works to augment the capacity of the stormwater drainage system by removing bottlenecks.
- Provide levels of service for stormwater drainage appropriate to the potential risks to the community in the specific area by taking into account the consequences of flood damages and frequency of flood occurrences.

- Impose strict controls on development in flood risk areas, especially on habitable/non-habitable floor levels, site grading and preservation of overland flow path to avoid adverse effects on the existing properties.
- Require source controls at contaminant hot spots, such as sections of roads with more than 5000 v.p.d, closed landfills and high risk industrial and commercial sites, to avoid diffusion of contaminants in the receiving environments.
- If practicable, provide centralised community stormwater management devices to avoid ineffective, often expensive, piecemeal stormwater treatment solutions.
- Involve local iwi groups in the stormwater management process and incorporate iwi philosophy in stormwater system design if practicable.

Other potential non-structural watercourse specific measures identified included:

- Implementation of a residents education programme on issues such as: use of fertilizer and pesticide, littering and illegal dumping, stock access to streams, car washing and car maintenance, native planting and animal dropping etc.
- Add logs, tree stumps and artificial eel holes etc. to increase habitat varieties at engineered channels.
- Install bio-engineering measures, such as green gabion and bio-logs, to protect the toe of streambanks at risk of erosion.
- Add meandering to engineered low flow channels to mimic sinuous natural stream channels.

The 2010 ICMP also provided a brief overview of earlier catchment management reports as outlined in sections 2.1.4.1 to 2.1.4.4 below.

2.1.4.1 Slippery Creek Catchment Flood Management Study 1990

This study was prepared by A.H. Snelder for the Auckland Regional Water Board and the Papakura District Council. The study aimed to manage and control flooding on a catchment wide basis, to inform future planning policies, and to identify remedial works.

2.1.4.2 Slippery Creek Catchment Flood Management Plan Study 1991

This study was prepared by A.H. Snelder based on the findings of the 1990 Flood Management Study. This plan recommends a range of land use management policies and flood protection works for the catchment. As a result of this plan, the Boundary Rd bridge was expanded, and floor levels were raised at Lipton Grove, Orion St, Smith Ave, and Marne Rd.

2.1.4.3 Sheehan Ave and Wing Crescent Flood Study 1991

This study was prepared by Rankine and Hill to model peak flood levels under existing and future catchment development scenarios with the aim of providing a 100 year return period level of protection to existing residential houses.

2.1.4.4 Markedo Place Flood Mitigation Study 1994

This study was prepared by Harrison Grierson Consultants Ltd. to model peak flood levels and identify risks to habitable dwellings.

2.2 Catchment Overview

The Slippery Creek catchment is predominantly rural. Its headwaters are the Hunua foothills which are largely covered in remnant or regenerating indigenous forest. Over 25% of the catchment is covered in indigenous forest and a further 5% of the catchment is used for exotic forestry (LCDB 4.0). The area is drained by four main watercourses, Slippery Creek, Hays Stream, Symonds Stream, and Waihoihoi Stream which discharge to the upper Pahurehure inlet via Slippery Creek. Currently, approximately 50% of the catchment is pastoral (LCDB 4.0) however 16.8% of the catchment is zoned for urban growth (PAUP), most of which is located in pastoral low lands. An additional 4.4% of the catchment is zoned for special purposes (including the Hunua Quarry).

The urban areas of the Slippery Creek catchment fall within the areas formerly known as the ‘Croskery Road Drain catchment’ and the ‘Bellfield catchment’ which are serviced by reticulated pipe networks (PDC, 2010).

Rural Papakura can be divided into two key characteristic areas; the flat, drained lands of the Manukau Ecological District, and the steep hill country in the western foothills of the Hunua Ecological District. These two ecological areas are delimited by the Drury fault line which runs from north to south. The lower catchment is mostly underlain by mud/gravel pumices with large swamp peat areas of low permeability (PDC, 2010). The eastern portion of the catchment consists of upthrusts of massive greywacke overlaid by clay topsoils. The greywacke is quarried as an aggregate resource by Hunua Quarry which was established in 1934 and expanded in 1958 (Winstone Aggregates, 2009).

Table 3: Catchment overview

Attribute					
Catchment Area (km^2)	46.3				
Geology	Puketoka Formation / East Coast Bays Formation				
% Imperviousness	8.2%				
	Public Open Space	**Rural**	**Residential**	**Business**	**New Growth**
PAUP Land Use Zoning (% catchment)	2.8%	63.6%	9%	3%	16.8%
Receiving Environment	Pahurehure Inlet, Manukau Harbour				

2.3 Catchment Development History

The Slippery Creek catchment has a long history of human occupation. The alluvial low lands and valleys west if the Drury fault line were modified by extensive forest clearance for cultivation, and for canoe construction, stream beds were also modified for the construction of eel weirs (Snelder, 1990).

Extensive swampland still persisted in the area up till the 1830's. Following European settlement, (including the eponymous William Hay) further modification and drainage was undertaken for cultivation, and the development of large cattle grazing runs (Snelder, 1990). The lower catchment was almost entirely in pasture by the 1870's, which also coincided with the extension of the railway line to the area, increasing development and urban growth (Snelder, 1990).

Major kauri timber milling operations commenced in the 1880's, resulting in deforestation, and physical change to the structure of streams (Snelder, 1990). The Hunua Quarry started operation in the early 1900's (Snelder, 1990).

Urban growth in the 1920's led to the construction of a weir in the upper Hay's Stream for water supply, consequently modifying streams both upstream and downstream (Snelder, 1990). A dam was then constructed in 1966-67. The Hays Creek Dam is a rolled earth embankment 27 m high at the deepest section with a crest length of 77 m. The dam impounds nearly 1 million m^3 of water when operating at capacity (Jairaj, 1998). Watercare Services Limited took over operation in 1989 (Jairaj, 1998). Major upgrades occurred in 1993-1994 to construct a graded sand chimney drain.

Residential growth increased in World War II associated with the Papakura Military Camp and Ardmore Aerodrome. Further expansion from the 1970's was enabled by the

extension of the southern motorway consequently increasing urban stormwater inputs to the catchment

The Croskery Road Drain between Settlement Rd and Boundary Rd was straightened and expanded in the 1960's to allow for expansion of the industrial sector (PDC, 2010). A major diversion at Dominion Road diverts all flow upstream to the Croskery Road Drain channel (PDC, 2010). All major stormwater pipes west of the Croskery Road Drain discharge into the drainage ditches formed along the rail corridor (PDC, 2010).

The upland section of the catchment, east of the Drury fault line has also been modified by deforestation and some subdivision has also taken place, primarily as small lifestyle blocks. Large areas of regenerating forest are present.

2.4 Prior Watercourse Assessment

Morphum Environmental conducted assessments of focal streams in 2013 to support the preparation of an Environmental Technical Assessment for the Manukau Consolidated Receiving Environment (CRE) which was prepared to support the Auckland Council Network Discharge Consent (Jackson *et al.* 2014).

Hays Stream and Slippery Creek were both identified as focal streams through this process. Hays Stream showed little evidence of impact with good water and sediment quality and high ecological value, essentially providing a reference condition for the area. Slippery Creek, however, had issues with heavy metal contamination (particularly within the vicinity of the residential development at Redcrest Reserve) and ecological values were negatively impacted.

An ecological assessment of sections of Hays, Symonds, and Waihoihoi Streams was completed within the vicinity of the Hunua Quarry by Golders Associates in 2011 to assess the impact of a proposed lowering of the Hunua Quarry pit floor (Golders, 2011). The proposed deepening of the pit and associated change in dewatering level has the potential to intercept a greater volume of groundwater which may affect baseflows in nearby streams within the defined zone of influence. Upper reaches of Hays Stream and Symonds Stream were considered to have high ecological value. These reaches were characterized by relatively intact native riparian margins, and rocky streambeds with a diversity of EPT taxa. Koura, eels, banded kokopu, and bullies were observed in these reaches. Stream reaches within lowland pasture or rural lifestyle landuse were mostly classed as 'moderate' to 'low' ecological value.

Lowland reaches with modified riparian margins typically had higher proportions of sand/silt, and macrophytes and filamentous algae were more common. Many of the smaller tributaries were very shallow with low flow which further facilitates the establishment of aquatic vegetation (Golders, 2011).

Stream Ecological Valuation (SEV) assessments were undertaken at eight sites across the Slippery Creek catchment in 2006 by NIWA to support the preparation of the Papakura ICMP (Phillips *et al.* 2006). Two sites on Hays Creek and one on Symonds Stream were defined as reference sites due to relatively minimal upstream urban development, intactness of the riparian zone and diversity of aquatic habitat. In general, Hays Creek was found to support a diverse faunal assemblage with good water and sediment quality and was functionally intact. Symonds Stream also had good aquatic habitat and was functionally intact in the upper reaches though some significant erosion issues were identified. Slippery Creek (including the Croskery Drain) was severely degraded with minimal aquatic habitat value. Elevated zinc concentrations in sediments and wastewater overflow issues were of concern. Further details of the SEV assessments at these sites can be found in section 4.0 of this report.

Key restoration measures recommended by Parkyn *et al.* (2001) include:

- Fencing for stock exclusion as most streams exceeded contact recreational criteria for *E.coli*.
- Fixing sewage overflows.
- Implementing riparian buffers (10 – 15 m wide riparian buffer around Croskery Drain was identified as a key enhancement opportunity).
- Ceasing spraying weeds and long grass along stream banks, drains, and road edges to combat bank instability issues.
- Investigation of waste management strategies to reduce litter dumping throughout the catchment.

Kelly (2008) concluded that from 1976-2006 sediment accumulation has increased the extent of mangrove cover in the Manukau Harbour by around 250%. This has occurred at the expense of other benthic habitats and mangroves are often perceived as a nuisance leading to illegal clearances particularly around the Pahurehure Inlet (Kingett Mitchel, 2005). Consented clearances have also been conducted by the Pahurehure Inlet Protection Society. The Slippery Creek catchment is predicted to be the greatest contributor of sediments to the Pahurehure Inlet and one of the second greatest contributors of heavy metal contaminants (Green, 2008).

2.5 Significant and Existing Ecological Values

Due to extensive land clearance and modification in the Manukau Ecological District, any remaining areas of vegetation or wetlands are considered to be significant and worthy of protection (Papakura District Plan 1999).

Remaining large bush areas within the Hunua Ecological District provide significant wildlife habitat (Papakura District Plan 1999). Protection from the effects of fragmentation through inappropriate subdivision is a primary concern of the Papakura District Plan.

The majority of the upper reaches of Waihoihoi Stream and Symonds Stream are located within Significant Ecological Area (SEA) SEA_T_5323. This 16.2 km^2 area has been identified due to its representativeness, threat status and rarity, diversity, and as a migration pathway.

The majority of the northern reaches of Hays Stream are located within SEA_T_409 whilst the eastern reaches lie within SEA_T_5289. Both of these are very large areas (5.4 km^2 and 1.7 km^2 respectively), which have been identified for their representativeness, threat status and rarity and diversity values.

All other, typically smaller SEA's located near the streams surveyed within the Slippery Creek catchment are outlined below in Table 4 including the key categories that have been identified for each area designation.

The Pahurehure Inlet extends 7.7 km from Weymouth to Papakura township. The marine Significant Ecological Areas SEA_M1_29b, and SEA_M2_29a include a variety of intertidal habitats in the upper Pahurehure Inlet. In the uppermost tidal reaches (in the vicinity of the Southern Motorway Bridge across the Slippery Creek stream mouth) are a variety of marshes demonstrating a vegetation sequence from mangroves to salt marsh to freshwater vegetation. This upper area also forms a significant migration pathway for many native freshwater fish (Schedule of Significant Ecological Areas).

Table 4: Significant Ecological Areas within the Slippery Creek catchment.

	Significant Ecological Area	Nearest Ecoline	Representativeness	Threat Status and Rarity	Diversity	Stepping Stone / Migration pathway / Buffer	Uniqueness or distinctiveness
Hays Stream	SEA_T_5277	HAY_MAIN_17 to HAY_MAIN_21		✓	✓	✓	
	SEA_T_5289	Hay_MAIN_29 to HAY_MAIN_35, HAY_TRIB6_3, HAY_TRIB6c_1	✓	✓	✓		
	SEA_T_5470	HAY_MAIN_40, HAY_MAIN_41, Hay_TRIB7_1				✓	
	SEA_T_409	TRB of Hay_MAIN_29 and upstream of HAY_TRIB3_6	✓	✓	✓		
	SEA_T_415	TRB OF HAY_TRIB6CI_4 to HAY_TRIB6CI_7		✓			
	SEA_T_413	HAY_TRIB6c_5, HAY_TRIBcI1_1, HAY_TRIB6cI_1, HAY_TRIB6cI_2, HAY_TRIB6c_7 to HAY_TRIB6c_9, HAY_TRIB6CII_1			✓		
	SEA_T_410	Upstream of HAY_TRIB6E_4			✓	✓	
Slippery Creek	SEA_T_4468	SLI_MAIN_43, SLI_MAIN_44	✓		✓		
	SEA_T_545	SLI_MAIN_6 to SLI_MAIN_8			✓		
	SEA_T_4469	Upstream of SLI_TRIB12_7	✓				
	SEA_T_4361	SLI_TRIB9_6, to SLI_TRIB9_9	✓	✓	✓		

	Significant Ecological Area	Nearest Ecoline	Representativeness	Threat Status and Rarity	Diversity	Stepping Stone / Migration pathway / Buffer	Uniqueness or distinctiveness
	SEA_T_4362	Urban Area north of SLI_TRIB4_FORK1_4	✓	✓			
Symonds Stream	SEA_T_77	SYM_MAIN_13	✓	✓			
	SEA_T_7032	TRB of SYM_MAIN_21		✓	✓	✓	
	SEA_T_7033	TRB of SYM_MAIN_22			✓		
	SEA_T_5430	SYM_TRIB2_12 to SYM_TRIB2_14			✓		
	SEA_T_4550	Upstream of SYM_MAIN_FORK2_TRIB8_1				✓	
Waihoihoi Stream	SEA_T_5323	Upstream of WAI_MAIN_20 and SYM_MAIN_23	✓	✓	✓	✓	
	SEA_T_4562	WAI_TRIB2_17 to WAI_TRIB2_20			✓	✓	
	SEA_T_4563	WAI_TRIB2_23 to WAI_TRIB2_27			✓	✓	
	SEA_T_1173	Upstream of WAI_TRIB7_7			✓		
	SEA_T_1174	Upstream of WAI_TRIB7_7		✓			
	SEA_T_1172	Downstream of WAI_TRIB2_26	✓	✓			
	SEA_T_1175	South of WAI_MAIN_21	✓	✓			
	SEA_T_4561	South of WAI_TRIB2_18		✓	✓	✓	

2.6 Cultural and Heritage Values

The traditional name for Papakura is Wharekawa (Papakura District Plan, 1999). The area was home to several iwi and hapu including Ngati Tamaoho, Ngati Akitai, Ngai Tai, and Ngati Pou (Papakura District Plan, 1999). An ancient papakainga of Ngati Tamaoho called Te Aparangi was located at Red Hill, traditionally known as Puke-Kiwi-O-Riki (PDC, 1999; Tatton, 2001).

Ngati Tamaoho have identified proposed name changes for three of the four main streams within the Slippery Creek catchment. Slippery Creek is proposed to be renamed 'Otuwairoa', loosely translated to mean 'the place where the long water stands'. Hays Creek is proposed to be renamed 'Waipokapu' which may be translated as 'the water shortcut or direct route'. Symonds Creek is proposed to be renamed 'Mangapu' which may be translated as 'double stream' (www.nzhistory.net.nz n.d.).

Archaeological records indicate that the valleys of the Drury-Papakura area were occupied, at least seasonally for gathering resources. Clusters of archaeological sites tend to occur adjacent to streams and on high ridges including Pa sites at red Hill (Heritage Place ID 652) and at Ponga Rd (Heritage Place ID 696) (Tatton, 2001). The swampy, poorly drained lowlands in the Papakura district would not have been suitable for Maori settlement.

The Maori view of the management of the margins of creeks and streams, as outlined in the Papakura District Plan, is that these should be left to revert to their natural state through weed control (spray-free). The Drury South Business Park area lies outside of the Slippery Creek catchment, however the cultural heritage assessment for the business project identifies that iwi advocate for the highest level of treatment of stormwater before it is discharged into waterways. A preference is also noted that waterways are managed to ensure their use as a food source and support for active restoration programmes including planting (Te Roope Kaitiaki O Papakura, 2010).

There are no post-colonial historic heritage sites identified in the PAUP within Slippery Creek catchment.

2.7 Community Involvement

Wai Care is a freshwater monitoring, education and action programme funded by the Auckland Council. Wai Care works with school and community groups across Auckland to monitor the water quality of local streams, undertake actions to support improved waterway health including rubbish clean ups and planting activities, as well as deliver educational talks about Auckland waterways. Wai Care have an active involvement within the Slippery Creek catchment across 12 sites working with a number of community and school groups.

There are currently nine Wai Care groups monitoring water quality and undertaking riparian restoration at 12 sites in the catchment for the past 10 years. Eight sites are on Slippery Creek, one site is on Symonds Stream and three sites are on Hays Stream.

Wai Care activities in the catchment include:

- Riparian planting in Slippery Creek Reserve by Drury School and Keri Downs Reserve by Department of Corrections;
- Water quality monitoring throughout the catchment;
- Rubbish clean-ups in Keri Downs Reserve and Mclennan Park; and,
- Weeding bees in Keri Downs Reserve, Mclennan Park and Slippery Creek Reserve.

Although community and school groups have undertaken many riparian planting days throughout the catchment over the last ten years, there has been ongoing issues with plants getting pulled out of the ground and many of the plantings have not survived. The majority of plantings get destroyed if they are located in reserves and parks, near where children play after school. Therefore, increased education and awareness about the importance and benefits of riparian planting is essential in this area to help decrease the damage to community plantings.

Wai Care have an active involvement within the catchment across twelve sites working with a large number of community and school groups.

Papakura District Council WaiCare Highlights 2009-2010:

- Slippery Creek Reserve – Drury School planted 535 plants.
- Department of Corrections prepared planting sites at Slippery Creek, weeded watered and maintained existing native plantings at Keri Downs Reserve and McLennan Park.
- Redhill School enjoyed cleaning adopted stream at Keri Downs Park.
- Drury Christian School monitors Slippery Creek at their farm.
- Drury School monitors at Slippery Creek Reserve.
- Kotare Cubs sampled Hays Stream.
- Save our Stream Papakura – Greenhaven Reserve.
- Matamua Girl Guides.

3.0 Summary of Findings

3.1 Ecoline

3.1.1 Physical Attributes

Watercourse assessment for the Slippery Creek catchment was undertaken between April and September 2015 and watercourse physical variables were reflective of winter conditions. Numerous large rain events occurred and consequently surveys were most commonly conducted 1 or 2 days following a rain event. This was taken into consideration when assessing the stream classification (permanent/ intermittent/ ephemeral/ OLFP). Physical variables of all reaches assessed are outlined below and summarised in Table 5. Refer to Map 1 in Appendix A for an overview of stream names and tributary codes referred to throughout this report.

The majority of stream reaches in the Slippery Creek catchment were soft bottomed channels dominated by silt/sand substrates. The second most common dominant substrate type was gravels. Nearly 50% of reaches assessed had >50% sediment deposition with 30% of these (nearly 15% of the total) impacted by >80% fine sediment deposition. The impacts of this were particularly apparent in some high land soft bottomed streams with up to a 1 m depth of loose unconsolidated sediment accumulated in slower moving reaches (Figure 3). The deposition of fines was also apparent in many of the 141 hard bottomed reaches in the catchment where accumulated fines may be higher than casual observation may suggest, blocking interstitial spaces and reducing the habitat values of these reaches.

Some degree of erosion was observed in the majority of reaches within the Slippery Creek catchment. There were 21 reaches (3.4% of reaches assessed) where erosion was identified to be greater than 60% of the reach on one or both banks, and a further 22 reaches with 40-60% erosion on either one or both banks. Overall Pfankuch upper bank stability was considered to be ‘fair’ for almost all of these reaches indicating the potential for ongoing bank erosion and slumping issues (see Table 6). Bank vegetation was fair to poor for all but five reaches. Banks were <1 m high for more than half of these reaches that were most impacted by erosion, with bank angles averaging 75^{o}, therefore revegetation may be a suitable option to consider to improve bank stability. For the remaining reaches, high banks (>1.5 m) and steep gradients (>75^{o}) may require further investigation into bank stabilisation options. Refer to Appendix A Map 4 for a summary of bank stability across the catchment.

One hundred and sixty nine reaches were observed with some kind of modification with a combined total reach length of 22,084 m (25% of assessed length); 45 of these reaches showed signs of three or more types of modification, The majority of modified reaches

were observed through industrial and residential areas of Slippery Creek for increased conveyance and bank stability, and modified channels increasing farm drainage in agricultural areas. Twenty-eight reaches (6,439 m) had some extent of bank and/or channel lining, the entire reach may or may not be lined. The actual length, type, and condition of sections of lining is discussed further in section 3.9.

Nearly 10% of assessed reaches were impacted by moderate to severe stock damage, all of which were accessible to stock. This does not include additional reaches where the channel had been so heavily damaged that no defined channel was present, resulting in wide shallow reaches dominated by facultative wetland vegetation, some wetland vegetation, and pockets of terrestrial vegetation. Refer to section 3.6 for more details. Despite the predominantly rural character of the Slippery Creek catchment, more than 60% of the assessed reaches were not damaged by stock.

Figure 3: Unconsolidated fine sediment on HAY_TRIB6cI_2

Table 5: Summary of physical variables across the extent of watercourse surveyed. Note adjacent land use and erosion scarring is assessed separately for the TRB and TLB therefore the total length will be double the surveyed area.

Attribute			
Total Length of Surveyed Watercourse (m)	87,179.3		
No. Reaches	604		
	Permanent	**Intermittent**	**Ephemeral**
Class (% of total stream length) (length of stream (m))	**83.9%** 73,101.8	**15%** 13,090.4	**1%** 892.9
	Mean	**Min**	**Max**
Reach Length (m)	144.4	10.5	1,525.2
Average Width (m)	1.6	0.2	10
Depth (m)	0.3	0.01	1.5
Bank Angle (degrees)	57.8	5	90
Bank Height (m)	0.9	0.05	15
Sediment Deposition (% accumulation)	49%	0%	100%

	Bush	**Park**	**Agricultural**	**Residential**	**Light Industry**	**Industrial**	**Impervious Surface**
Adjacent Land Use (% of total stream length) (length of stream (m))	**37.5%** 65,363.1	**3%** 5,204.5	**47.8%** 83,306.9	**4.7%** 8,200.2	**1.2%** 2,130.1	**2.9%** 5,105.5	**2.9%** 5,048.3

	Artificial	**Bedrock**	**Boulder**	**Cobble**	**Gravel**	**Silt/Sand**
Dominant Substrate (% of total stream length) (length of stream (m))	**0.1%** 90.5	**1.2%** 1,036.4	**0.5%** 435.8	**8.7%** 7,579.8	**26.1%** 22,773.9	**63.4%** 55,262.9

	Widened	**Straightened**	**Deepened**	**Lined**
Channel Modification (% of total stream length) (length of stream (m))	**11.6%** 10,098.7	**14.7%** 12,857.2	**12.1%** 10586.7	**7.4%** 6,439

	0%	**≤20%**	**20-40%**	**40-60%**	**≥60%**
Erosion Scarring (% of total stream length) (length of stream (m))	**2.6%** 4,615	**79.2%** 138,063.5	**13.2%** 23,020.4	**2.1%** 3,677.9	**2.9%** 4,981.8

	None	**Minor**	**Moderate**	**Severe**	**NA**
Stock Damage (% of total stream length) (length of stream (m))	**60.3%** 52,551.3	**24.1%** 21,032.8	**5.7%** 4,952.3	**2.6%** 2,253.5	**7.3%** 6,389.4

Table 6: Summary of Pfankuch bank stability assessment of the total length of watercourse (m).

	Excellent	Good	Fair	Poor
Land Slope	14,322.7	18,268.8	16,261.3	38,326.5
Mass Wasting	16,552.9	38,491.0	23,653.2	8,482.2
Debris Jam	21,097.7	45,317.5	19,039.8	1,724.3
Bank Vegetation	7,624.8	24,966.0	30,440.9	24,147.6
Overall Stability Index (% of total stream length) (length of stream (m))	**0.4%** 320.0	**40.5%** 35,323.4	**53.8%** 46,911.4	**5.3%** 4,624.5

3.1.1.1 Slippery Creek

Slippery Creek is the main water body that discharges into the upper Pahurehure Inlet. The other three streams discharge to the main channel of Slippery Creek at two key confluences at SLI_MAIN_5 (Symonds and Waihoihoi Streams), and SLI_MAIN_19 (Hays Stream).

***Southern, Downstream Sector (*SLI_MAIN_1-22)**

The lower 4.3 km of the main channel of Slippery Creek (SLI_MAIN_1-22) is currently predominantly rural land use.

The main channel of Slippery Creek averaged 10 m wide and up to 12 m wide in the lower reaches, narrowing to an average width of 4 m upstream of the Symonds/Waihoihoi confluence, and further narrowing to <2 m wide upstream of the Hays Stream confluence. The lower reaches of the stream averaged 1.5 m depth except at the mouth of Slippery Creek which is constrained to a depth of 0.1 m by a bedrock chute at the southern motorway overpass. Upstream of the Hays Stream confluence average depth was approximately 0.3 m. Downstream of the confluence with Symonds/Waihoihoi Stream floodplain connectivity would be often or 'frequent' with low gradient banks <0.5 m high. Upstream of this confluence, average bank height varied between 1 and 4 m with typically V-shaped channel profiles, with less than 20% bank erosion and 'fair' bank stability.

***Industrial Sector* (SLI_MAIN_23-30)**

Upstream of Boundary Rd, 1.6 km of the main Slippery Creek channel passes through the industrial sector of Papakura that is delimited by Dominion Rd to the northeast. This section of stream is commonly known as the 'Croskery Drain'. All ten reaches through this sector had been modified to a fairly uniform average width of 1.8 m, most of which had likely also been deepened to improve conveyance. A riparian corridor approximately 15 to 20 m wide throughout the industrial sector had been fenced off.

***Graham Tagg Park* (SLI_TRIB4)**

Tributary 4 includes a series of uniform straightened drainage channels (1.2 m wide, 0.1 to 0.5 m deep) through Graham Tagg Park, a former golf course currently used for informal recreation and designated as a special housing area.

***Railway corridor* (SLI_TRIB5, SLI_TRIB6)**

SLI_TRIB5 is located at the western side of the railway line, while SLI_TRIB6 is on the eastern side, at the Boundary Rd intersection. Both channels were straightened and averaged 0.3 m deep at the time of survey. TRIB5 varied between 2 and 5 m wide while TRIB6 was narrower at 1.5 to 3 m wide. Sediment deposition was variable along these soft bottomed reaches with the greatest deposition in pooled areas at the upstream end of TRIB 6 and the downstream reach of TRIB5. Both reaches had good bank stability and minimal erosion. A new subdivision was under construction on the true right of SLI_TRIB5 and stream works were underway over the assessment period. New planting of *Carex spp.* had been installed at a later visit to the area.

***Kerri Downs Park* (SLI_MAIN_32, SLI_TRIB9_1-5)**

SLI_TRIB9 is piped for a distance of approximately 260 m before discharging at SLI_MAIN_28 via asset:1115254 (pipe: 1132928). SLI_MAIN_32 receives the discharge from the Carisbrook stormwater pond.

These reaches were narrow and shallow, typically 1 to 1.5 m wide with an average depth of 0.2 m. Several of these reaches also showed signs of widening and deepening. Moderate erosion scarring was evident along some of these reaches, and channels appear to be actively down cutting, exposing a compacted clay base with minimal sediment deposition. SLI_TRIB9_5 had recently been recontoured and reinforced with gabion basket bank lining on the nearly right angled turn at the north-eastern end of Keri Downs Park.

***Upper Headwaters* (SLI_MAIN_33-47, SLI_TRIB9_6-12, SLI_TRIB10, SLI_TRIB11, SLI_TRIB12).**

Slippery Creek is piped for approximately 750 m between SLI_MAIN_32 and SLI_MAIN_33. Approximately 2.8 km of open watercourse was assessed upstream of the piped network including SLI_MAIN_33-47 and SLI_TRIB12. The majority of these reaches pass through lifestyle, low density residential housing, however the headwaters (SLI_MAIN_46-47) are located within predominantly native regenerating bush.

These reaches typically averaged 1 to 1.3 m wide, and 0.2 m deep, with low banks and active floodplains dominated by *Glyceria* spp. Several reaches were considerably wider where mature willows had created a more braided channel morphology.

Figure 4: Reach modified by willows on SLI_MAIN_34

Between 400 to 700 m of piped network separates tributaries 10, 11, and 9 (reach 6-12) from the downstream reaches at Keri Downs Park.

Tributary 10 was impacted by willows in the lowest reach, whilst the upper reaches (2-6) were actively down cutting and scour at the toe of the bank was evident. An online pond had been constructed which had completely diverted reach SLI_TRIB10_8 from the original channel through regenerating nikau forest (Figure 5). Banks had not yet fully formed at the new channel and the base was completed lined by willow root, with a layer of fine sediment trapped in the roots (Figure 5).

Figure 5: Newly formed channel lined by willow root (SLI_TRIB10_8) (left) and parallel original dry channel (right).

The upper reaches of tributary 9 were on the southern border of the Children's Forest. The channel was typically narrow (0.3 m), shallow (0.1 m) and had a steep gradient with a

series of cascades in the lower reaches. The lower two reaches (TRIB9_6-7) were dominated by bedrock and poured in situ concrete.

3.1.1.2 Waihoihoi Stream

A total of 27 km of watercourse was assessed along Waihoihoi Stream including 10.5 km of intermittent to ephemeral stream.

The main channel of Waihoihoi stream was 1.7 km long between the downstream confluence with Slippery Creek, and the upstream confluence with Symonds Stream. The main channel averaged 2 to 2.5 m wide and 0.4 to 1.2 m depth. Banks were typically 1.5 to 2 m high with a moderate slope of 60 to 80^{o}. Erosion was typically <20% and overall upper bank stability was considered to be fair due to evidence of some historical mass wasting, debris jams, and lack of bank stabilising vegetation. Most reaches were unfenced, however damage to the banks was minor due to bank height reducing accessibility. The predominantly pastoral landscape was interspersed with scattered willows that were not affecting the hydrology of the stream although large woody debris was contributing to minor debris jams on several reaches. Small stands of mature kahikatea and totara were also common.

***Low land agricultural* (WAI_MAIN_9-14, WAI_TRIB2_1-16, WAI_TRIB4, WAI_TRIB5)**

Upstream of the confluence with Symonds Stream, the Waihoihoi main and Tributary 2 branches. The main Waihoihoi channel was similarly wide (1.5 -2.5 m) above the confluence however average depth decreased to 0.2-0.4 m and average bank heights increased to >1.5 m. The dominant substrate changed from silt/sands to gravels upstream of WA_MAIN_10 with lower sediment deposition (<50%) overall however higher deposition was observed near localised erosion hot spots.

The greatest levels of erosion were observed at WAI_MAIN_11-14 (740 m) and WAI_TRIB2_2-7 (575 m), 13 erosion hotspots with a combined area of 550 m^2 were recorded between WAI_MAIN_10 and WAI_MAIN_14 (approximately 1.5 km total length of stream), refer to section 3.10 for more details. As expected, erosion was typically greatest on the outside of each meander on this highly sinuous stream where sheer banks were approximately 2 m high. Historical, healed over areas of bank slumping formed a lower terrace within the main channel that would be frequently inundated by flood flows.

Tributary 2 is a main tributary of Waihoihoi stream including 4.3 km of assessed watercourse. Approximately 1.7 km of the main channel of tributary 2 passes through the western pastoral part of the catchment. The majority of the reaches of this tributary had been widened and straightened as farm drainage canals. The channel was narrower than the main Waihoihoi Stream (0.8-1.4 m) and shallower (0.1-0.3 m deep). The banks had been contoured to a lower gradient of approximately 60^{o} to a total height of 3 m. However due to downcutting and side cutting, the immediate bank edge was nearly vertical to a

height of just under 1 m. These reaches were dominated by silt/sand substrates with only 5 to 20% gravels.

Figure 6: Representative reach of the main channel of WAI_TRIB2 with a close up of side cutting.

***Lifestyle/hills* (WAI_MAIN_15-20, WAI_TRIB2_16-27, WAI_TRIB7)**

The underlying geology of the catchment changes from peat to greywacke at the foot of the Hunua ranges along the Drury fault line, this contributes to a defined change in character between the lowland agriculturally dominated streams and the upper reaches which also tend to be managed as residential lifestyle properties rather than intensive farming.

The mid reaches of WAI_MAIN (15-19) were physically similar to the lower reaches, 1.5-2.5 m wide, gravel substrate, 0.2 m deep, with slightly lower banks (0.6-1 m average). Four of these reaches had also been reinforced with bank lining in small sections.

The upper reaches of WAI_TRIB2 increased in gradient with several waterfalls and cascades along the 1.2 km of assessed watercourse and a higher proportion of cobble to boulder dominated substrates. These reaches also had a higher degree of habitat heterogeneity forming riffle-run-pool sequences. Bank heights were typically less than 1 m except at WAI_TRIB2_24 where a steep grade control occurred with banks up to 15 m high.

***Native forest* (WAI_MAIN_20-25, WAI_FORK1, WAI_FORK2)**

The uppermost reaches of Waihoihoi Stream include 6.7 km of assessed watercourse that originates in the remnant broadleaf forest that forms part of Significant Ecological Area SEA_T_5323.

Average channel width increased at WAI_MAIN 20-25 to 3-4 m wide with several pools up to 0.7 m deep, constricting again to approximately 1.3 m wide on each fork after the confluence. These upper reaches were dominated by either gravel of cobble substrates, however a fine layer of sediment deposition, blocking interstitial spaces was observed for

the majority of these reaches. Erosion was less than 20% though overall bank stability was typically fair due to the steeply sloping upper banks up to 30 m high in some places.

3.1.1.3 Symonds Stream

A total of 20 km of watercourse was assessed along Symonds Stream including 2.6 km of intermittent to ephemeral stream.

***Low land agricultural* (SYM_MAIN_1-22, SYM_TRIB1, SYM_TRIB2_1-11)**

The main channel of Symonds Stream averaged 1.8 to 3 m wide with an average depth of 0.2 to 0.4 m. Average bank height was typically 1.5 to 1.8 m, however five reaches had average bank heights >2 m. The stream was highly sinuous and, as expected, banks tended to be higher on the outside corners of meanders where bank erosion was greatest.

Bank erosion was variable throughout this area typically ranging from 20-40% to 40-60% from SYM_MAIN_1 to SYM_MAIN_9, <20% between reaches 11-19, >60% erosion along the 829 m of SYM_MAIN_20, and 20-40% along SYM_MAIN_21-22. Several erosion hotspots, stabilised land slips, and exacerbating debris jams caused by mature willows and felled trees were also recorded throughout this area (refer to section 3.10 for more details). Reaches 11 to 20 were dominated by gravel substrates whilst the lower reaches were dominated by silt/sands. Several reaches were also affected by channel erosion, resulting in scour holes in the clay base and areas of localised sediment deposition up to 0.4 m deep in occasional pools.

TRIB1 was a predominantly straightened farm drainage channel including 1.8 km of assessed watercourse. The channel was typically 0.5-1 m wide with an average depth of 0.2 m. This channel was dominated by silt sands, minimal erosion, and good upper bank stability.

Tributary 2 was approximately 1.1 km long, with the upper 200 m originating in the highlands in remnant native forest. The tributary discharges to the main channel at SYM_MAIN_15.

***High land native forest* (SYM_MAIN_23-27, SYM_MAIN_FORK1, SYM_MAIN_FORK2, SYM_TRIB2_12-15, TRIB3, TRIB5_5-6)**

The upper 7 km of the main channel of Symonds Stream, the entirety of FORK 1 (5.6 km), the majority of FORK 2 (3.9 km) (a total of 1 km of intermittent stream), and the 600 m length of TRIB3 were within the predominantly native forest that forms part of SEA_T_5289.

The upper reaches of the main channel of Symonds Stream were typically 2.5 to 3 m wide but up to 5 m wide in places with an average depth of approximately 0.4 m except for SYM_MAIN_24 which averaged 0.7 m deep with pools up to 1.3 m deep. The reaches

where predominantly graveled with a higher proportion of cobbles and boulders than downstream (Figure 7). Banks averaged 0.4 to 2 m high with less than 20% erosion.

The reaches and tributaries of Fork 1 were highly variable in morphology ranging from narrow incised channels 0.5 m wide to 2 m wide. The average depth across most reaches was 0.1 m however some reaches had pools up to 0.8 m deep. Average bank height varied between 0.6 and 2 m and the dominant substrate ranged from silt sand, to gravels, to cobbles, to bedrock. Overall upper bank stability was ‘fair’ across all reaches despite good to excellent vegetation due to steep bank angles and steep upper banks rising 20 m in elevation to the ridge line within 15 m of the stream channel in some areas.

SYM_MAIN_FORK2 average 2.5 m wide in the lower reaches, narrowing to <1 m. Average depth was typically 0.2 to 0.5 m and banks averaged 0.5 to 1 m except at SYM_MAIN_FORK2_1 (2 m high). The lower reaches of the main channel of FORK 2 were dominated by gravels however the upper reaches (FORK2_8-14) were dominated by silt/sands. This change is substrate may be due to sedimentation from blocks of exotic forestry in FORK2_8,9 and 15 that intersect the regenerating native forest upstream, pastoral land use in upstream reaches, and high bank erosion (>60%) along FORK2_10-13. An online farm pond separates FORK2_7 and 8 which settles out some sediment. Six reaches (770 m) also had >90% fine sediment deposition.

Figure 7: SYM_MAIN_26

High land agricultural **(SYM_MAIN_FORK2_15-19, SYM_MAIN_FORK2_TRIB5, SYM_MAIN_FORK2_TRIB7, SYM_MAIN_FORK2_TRIB8)**

Approximately 13 km of watercourse, including the upper reaches of SYM_FORK2, and FORK2_TRIB5, 6 and 8 (including 640 m of intermittent to ephemeral stream), was assessed in the upper reaches of SYM_MAIN_FORK2. Average elevation on the ridgelines was 210 m dropping to 190 m in stream gullies.

MAIN_FORK2_18-19, TRIB8, and TRIB7_2 where dominated by pastoral land use while the remainder of the reaches in this section were within mature exotic forestry blocks with some mixed to native regenerating understory in the riparian corridor.

The reaches in this section were typically narrow (0.5 m wide) and shallow (0.2 m deep) with average bank heights between 0.4 and 0.9 m. All were soft bottomed streams with 70-90% fine sediment deposition. Bank erosion was typically greater than 20% on permanent reaches and some narrow channels were highly incised and actively down cutting. Minor stock damage was common however some of this damage is likely to be due to feral goats as almost all permanent reaches were fenced.

Recent flood flows had resulted in fine sediment deposition on the floodplains and low gradient banks of several reaches in the upper most reaches of SYM_MAIN_FORK2.

3.1.1.4 Hays Stream

Hays Stream includes over 30 km of assessed watercourse including 6.1 km of intermittent to ephemeral watercourse. 11.3 km of assessed watercourse discharges to the Hays Creek dam. The main channel of HAY_MAIN_6_3-7, 4 to 7 m wide immediately upstream of the dam, narrowing to 1.5 m wide running parallel to Creighton's Rd.

Industrial border **(HAY_MAIN_1-15)**

The southern boundary of the industrial sector is bordered by Hays Stream.

HAY_MAIN_1 is the only reach to the east of the southern train line. Approximately 2 km of permanent stream extends from the western side of the train line to the end of the industrial sector at the Hunua Rd/Dominion Rd intersection.

Reaches in the section averaged 2.5 to 5.5 m wide, 0.3 to 0.5 m deep, with variable bank heights averaging 0.6 to 2 m. The majority of reaches were dominated by gravels and cobbles with 20 to 30% fine substrate filling interstitial spaces. Fine sediments through this section were not easily disturbed and there was minimal evidence of fine sediment deposition. Erosion was typically <20% and upper bank stability was 'fair' to 'good' primarily due mature willows forming debris jams and diverting flows into channel banks on many reaches.

Terraces within the main channel were common which would be ‘often’, or ‘frequently’ inundated by flood flows.

***Hunua Road* (HAY_MAIN_16-36)**

Approximately 2.2 km of stream runs parallel (with some large meanders northwards) to Huna Rd. The channel was typically wide (4-5 m) with maximum width of 6 to 7 m for many reaches, with an average depth of 0.2-0.3 m (0.6 to 1 m in pools and on the outer bends of meanders).

The immediate banks were typically <0.6 m high with accessible floodplains, however upper banks increased sharply when the channel passed immediately below the road, and average bank height was 6 m. Other sections that abut the Drury Fault line also had sheer banks on the true right (HAY_MAIN_19).

***Northern Tributaries* (HAY_TRIB3, TRIB4)**

Tributary 3 of Hays Stream passes through blocks of mature pine plantation interspersed with pasture, over a total length of 1.3 km. Upstream of Hay_TRIB3_6 the channel continues within Ministry of Defence land. No further assessment was undertaken in this area.

The lower channel ranges from 0.8 to1.3 m wide with banks typically less that 1.3 m high however on TRIB3_6, bank height was up to 4 m on the outside of meanders. All reaches were dominated by gravels, sediment deposition was greatest at HAY_TRIB3_2 (75%).

Tributary 4 originates to the north of the Hunua Quarry near Ardmore Quarry Rd from a farm pond formed at a headwater seepage. The channel showed minor pugging from feral pigs along the banks and fine sediment deposition was high along the entire 574 m of HAY_TRIB4_2.

The channel was narrow at the headwaters (0.9 m) widening to 2 m with sheer banks 2.5 m high near the confluence with HAY_MAIN_29.

***Hays Creek Dam (Water Reservoir Tribs)* (HAY_TRIB6a, b, d)**

Both tributaries a and d were intermittent streams originating in gullies on the edges of the Hays Creek Reservoir. Only a short section (16 m) at the head of the gully formed a defined channel, widening to form a riverine wetland. Tributary d formed a narrow defined channel approximately 0.2 m wide with low banks approximately 0.3 m in height near the headwaters. Numerous boggy areas and isolated pools were observed within the floodplain of the main channel. Access through this area was very difficult due to dense thickets of supplejack (*Ripogonam scandens*) and the downstream reaches were not fully assessed. The most downstream reach of tributary 6c was located within mature tariare forest in the reservoir area. This reach averaged 3.5 m wide and was dominated by

bedrock with large boulders and cobbles. Banks were typically 0.9 m high and formed runs with a few stepped riffles and pools associated with cascades.

Figure 8: HAY_TRIB6c_1

***Hays Stream Northern High Land Agricultural* (HAY_TRIB6e, g, h, I, j, k, l, m, n)**

Many reaches of TRIB6e,f,I and k were impacted by high loadings of fine silt deposition typically around 0.4 m depth of unconsolidated sediment but up to 0.9 m of unconsolidated sediment in slower moving reaches on HAY_TRIB6kl_1. Bank erosion and stability was typically good throughout this area with the exception of HAY_TRIB6j. TRIB6j was formed a narrow defined channel that was actively incising up to 1.6 m deep however banks were most commonly 0.6 m high.

Deer farming was common in this area, including HAY_TRIB6i, TRIB6j, and TRIB6k, the majority of these reaches were fenced off and not accessible to stock.

***Hays Stream Eastern High land agricultural* (HAY_MAIN_36-52, HAY_TRIB5, TRIB6c, TRIB7, TRIB8, TRIB9, TRIB10, TRIB11, TRIB12)**

Many reaches of TRIB6c were impacted by high loadings of fine silt deposition typically around 0.4 m depth of unconsolidated sediment but up to 0.9 m of unconsolidated sediment in slower moving reaches on HAY_TRIB6cl_2. Bank erosion and upper bank stability was typically good throughout this area however more than 1.6 km of assessed watercourse showed signs of moderate to severe damage to the channel caused by stock access and a further 0.7 km had minor damage all of which were accessible to stock from both sides of the watercourse. This resulted in damaged banks, with no clear point of inflexion, banks therefore typically averaged 0.2 to 0.3 m high. The majority of TRIB6c formed gullies approximately 10 to 15 m wide with boggy riverine wetlands with an average depth of 0.1 to 0.3 m, some with a defined channel, and others that were more

diffuse. Pugging resulted in a mixture of terrestrial and facultative wetland vegetation crossing most of the wetland area. There was evidence that some reaches had been modified to increase conveyance on one side of the wetland such as HAY_TRIB6c_6 (Figure 9).

Several reaches had been fenced off and revegetation works were underway, and this was indicated to be an ongoing interest of the landowner. It is also worth noting that a significant land slip adjacent to Jones Rd had occurred which the landowner had replanted to stabilise the slope. It is possible that this was a source of some of the sedimentation issues observed downstream.

Figure 9: Channel on the TLB of HAY_TRIB6c_6 with raupo dominating the true right. Soil castings can be seen on the TLB. Photo facing upstream.

3.1.2 Water Quality Attributes

Approximately 20% of all reaches assessed had anaerobic odours or bubbling sediment present in parts of the reach. More than 70% of these reaches were located within agricultural areas. The majority of reaches with anaerobic conditions also had high levels of fine sediment deposition, averaging 70% sediment accumulation within these reaches. Approximately 60% of reaches with anaerobic conditions were also affected by some level of stock damage, >20% emergent or submergent macrophytes or periphyton, less than 30% overhead cover, or a combination of these factors.

High turbidity with opaque, cloudy water was observed on several reaches including SLI_TRIB4_FORK2 at Graham Tagg Park and SLI_TRIB5a_1 at the railway corridor.

Figure 10: High turbidity, and abundant green filamentous periphyton at SLI_TRIB4_FORK2_3

Eight other incidents of potential water contamination were observed:

- Foam observed at SLI_TRIB4_1, SLI_MAIN_40, HAY_MAIN_15, HAY_MAIN_16, and HAY_MAIN_30;
- Orange runoff from sprayed cleared bank on SLI_TRIB7_2;
- Sediment contamination from adjacent land development with no erosion or sediment control measures in place on HAY_MAIN_7. This was reported to Council on the 25th of May 2015 (Ref: 15/1179);
- A small drainage pipe (<225 mm) discharging into a storm water pond at SLI_MAIN_38 had sewage fungus present.

Table 7: Summary of watercourse contamination

Attribute	**Number of observations**		
Sewage Fungus	0*		
Petroleum/Hydrocarbons	0		
Anaerobic Conditions	126		
Other	8		
	Mean	**Min**	**Max**
Clarity**	79.9	55	95

* One pipe <225 mm in diameter with sewage fungus present

**From SEV results only

3.1.3 Biological Attributes

3.1.3.1 Vegetation

A summary of riparian vegetation characteristics is provided in Table 8. General patterns in riparian management are outlined below followed by general descriptions of each stream.

A buffer width of >10 m on either side of the stream has been recommended as a minimum requirement for indigenous succession reducing maintenance and weed infestation (Parkyn *et al.* 2000). However, the optimum width is 15 m or more with a higher likelihood that the buffer strip will support self-sustaining, low maintenance native vegetation (Parkyn *et al.* 2000). Forty percent of the reaches assessed catchment had average riparian margins ≥10 m wide on one or both banks. More than 50% of the reaches assessed had less than 10 m wide riparian margins on both banks with a total length of 48,202.8 m, nearly half of this length, having no continuous riparian margin (grasses only or scattered scrubs and trees). Refer to Map 5 in Appendix A for a summary of overhead cover across the catchment.

Fifteen permanent reaches (1,960 m total) were identified that had riparian margins greater than 10 m wide on one bank and less than 5 m or no riparian vegetation on the opposite bank. An opportunity exists to complete these riparian corridors.

Overhead shading of 70% is predicted to be sufficient to restore small pastoral stream temperatures to <20 ^{o}C (Young *et al.* 2013). The upper water temperature limit set by the Auckland Council Water Quality monitoring objectives is 19 ^{o}C (Lockie and Neale 2012). It is possible that sufficient shading may buffer thermally enriched point source discharges to the watercourse from the stormwater network although these relationships require further investigation (Young *et al.* 2013). The benefits of increased overhead cover must be balanced against the effects of shading out ground cover that provides bank stability. Overhead cover >70% can reduce ground cover and cause channel widening up to the tree line. Auckland Council TP349 suggests that planting primarily sedges within 5 m of stream edges could be implemented to combat this effect as well as attempting to maintain maximum overhead cover levels at 70% (Parkyn *et al.* 2001). More than 50% of the total length of surveyed watercourse had riparian overhead cover levels of between 70 and 90%, however more than 20% had overhead shading less than 30%.

Indigenous riparian planting had been undertaken on 22 reaches across the catchment (2,070 m), 10 of which had been planted on both banks (1,066 m). Planted reaches included one reach within the ‘Croskery Drain’ area, narrow shelterbelts along straightened channels within Graham Tagg Park, some sections of Keri Downs Park, the upper reaches of SLI_TRIB9 adjacent to the Children’s Forest, and several disconnected sections throughout both the lowland, and high land agricultural reaches.

Slippery Creek

***Southern, Downstream Sector (*SLI_MAIN_1-22)**

The lower reaches of Slippery Creek were dominated by pastoral, and lifestyle land use. Riparian margins were dominated by pastoral grasses with no understory, shelterbelt or other isolated canopy trees including mature totara and willows were common in this area.

Industrial Sector (SLI_MAIN_23-30)

A riparian corridor approximately 15 to 20 m wide throughout the industrial sector had been fenced off. Only two reaches (SLI_MAIN_29, 30) had been planted, however SLI_MAIN_30 was still dominated by *Glyceria* and further planting is recommended. The other reaches were dominated by exotic weeds, particularly blue morning glory, *Glyceria*, blackberry, and buttercup. The floodplains showed signs of frequent inundation (Figure 11).

Figure 11: Representative photo of Croskery drain facing upstream. Flattened *Glyceria* in floodplain on TRB, blackberry and woolly nightshade exotic scrub on TLB.

***Graham Tagg Park* (SLI_TRIB4)**

Graham Tagg Park is the site of a former golf course which is currently used for informal recreation. The park is dominated by pastoral grasses with narrow hedgerows of native shrubs along some of the drainage channels intersecting the park.

***Kerri Downs Park* (SLI_MAIN_32, SLI_TRIB9_1-5)**

Planting had been conducted by WaiCare groups along several reaches in Keri Downs Park in 2009. However, at the time of survey, the majority of this vegetation was no longer present. It was evident that the margins of the watercourse are currently being managed through spraying.

Channel modification works (bank recontouring) had recently been conducted in the north eastern end of the park on SLI_TRIB9 and these banks had been planted with *Carex* spp. in the floodplain.

Waihoihoi Stream and Symonds Stream

The lower reaches of Waihoihoi Stream and Symonds Stream were almost exclusively dominated by exotic pasture grasses with patches of mixed or exotic scrub and mature willows on the immediate margins. Shelter belts of poplar or other exotic trees were also common on stream margins (Figure 12).

Three areas of noteworthy indigenous vegetation were observed within the low land agricultural areas of Waihoihoi and Symonds Streams, a patch of kahikatea on WAI_MAIN_6, a remnant stand of karaka on SYM_MAIN_7 (Figure 13), broadleaf forest and kahikatea on SYM_MAIN_14-15. None of these areas are designated significant ecological areas. Stock access to these areas is also inhibiting natural regeneration within these areas.

Figure 12: Shelter belt on SYM_MAIN_20

Figure 13: Remnant stand of karaka and titoki on SYM_MAIN_7 approximately 2000 m^2

The upper reaches of the forks of both Symonds Stream and Waihoihoi Stream showed a lot of fine scale variation in vegetation type and successional stage, however overall these areas consisted of regenerating broadleaf forest with the stream gullies dominated by tree ferns and nikau (Figure 14).

Figure 14: Representative reach of the forks of Symonds Stream and Waihoihoi Stream dominated by tree ferns and nikau with parataniwha understorey.

Hays Stream

The main reaches of Hays Stream along the border of the industrial zone were dominated by mature willows with little to no understory, with the ground cover dominated by pasture grasses and weeds (Figure 15).

Upstream of the Boundary Rd/Hunua Rd intersection, the main channel of Hays Stream follows Hunua Rd along the gorge towards the Hays Creek dam. The northern side of the stream (true right bank) included mixed broadleaf forest and kanuka. The true left bank was typically dominated by blackberry, or gorse and pampas with some kanuka scrub. Edge effects were also apparent with the spread of exotic weeds to the margins of the true right bank (Figure 16).

The immediate boundaries of the Hays Creek Dam watershed included mature taraire forest. The upper tributaries of Hays Stream reverted to primarily pastoral land use however riparian buffer strips dominated by mature wattle were common through the northern sector. Gorse was also much more prevalent in this region.

Figure 15: Willow dominated riparian margins representative of HAY_MAIN_1-15

Figure 16: Hays Stream, Huna Road

Table 8: Summary of riparian vegetation across the extent of watercourse surveyed. Note that Average Riparian Width, Vegetation Height Categories, and Dominant Vegetation Type are assessed for each bank separately so the sum total length will be twice the total length of surveyed watercourse.

Attribute						
Length of Surveyed Watercourse (m)			87,179.3			
No. reaches (Ecolines)			604			
	Mean		**Min**		**Max**	
Percentage of intact vegetation within reach.	**44%**		**0%**		**100%**	
	≤10 %	**≤30%**	**≤50%**	**≤70%**	**≤90%**	**>90%**
Average Overhead Cover (% of total stream length) (length of stream (m))	**8.7%** 7,579.1	**13%** 11,374.9	**15.3%** 13,298.0	**24.9%** 21,744.7	**28.5%** 24,857.3	**9.5%** 8,325.3
	0m	**≤5m**	**≤10m**	**≤15m**	**≤20m**	**>20m**
Average Riparian Width (% of total stream length) (length of stream (m))	**29.5%** 51,442.1	**22.3%** 38,779.0	**7.5%** 13,059.9	**4.9%** 8,603.0	**5%** 8,843.6	**30.8%** 53,631.0
	Native		**Mixed**	**Exotic**		**None**
Canopy (% of total stream length) (length of stream (m))	**36.4%** 63,509.8		**10.6%** 18,534.6	**19.3%** 33,713.3		**33.6%** 58,600.9
Understorey (% of total stream length) (length of stream (m))	**30.2%** 52,711.6		**21.3%** 37,070.7	**17.2%** 29,934.6		**31.3%** 54,641.7
Groundcover (% of total stream length) (length of stream (m))	**19%** 33,070.1		**22.9%** 39,970.7	**56.4%** 98,400.4		**1.7%** 2,917.4
	Grassed	**Planted**	**Low Growing**	**Scrub**	**Regenerating**	**Mature**
Dominant Vegetation Type (% of total stream length) (length of stream (m))	**38.4%** 66,976.4	**1.8%** 3,136.9	**1%** 1,731.2	**15.7%** 27,329.3	**28.5%** 49,656.2	**14.6%** 25,528.6

Table 9: Summary of in stream vegetation across the extent of watercourse surveyed.

	None	≤20%	20-50%	>50%
Submerged Macrophyte Cover (% of total stream length) (length of stream (m))	**36.3%** 31,665.0	**59.2%** 51,642.0	**4.3%** 3,715.4	**0.2%** 156.9
Emergent Macrophyte Cover (% of total stream length) (length of stream (m))	**42.1%** 36,691.4	**37.5%** 32,683.4	**8.4%** 7,293.9	**12.1%** 10,510.6
Periphyton Cover (% of total stream length) (length of stream (m))	**37.5%** 32,681.7	**53.6%** 46,711.9	**8.7%** 7,584.5	**0.2%** 201.2

3.1.3.2 Habitat

The most common stream habitat type was runs, with more than 80% of assessed reaches dominated by 70% or more of this habitat type. Only two reaches had a good proportion of stable undercutting (HAY_TRIB1_6 and HAY_TRIB6e3). See Table 10 for a summary of habitat diversity.

Hays Stream had multiple areas of high habitat diversity including along the southern border of the industrial sector, in the Hunua Gorge downstream of Hays Creek dam, and other forested sections of TRIB 4, TRIB5, and TRIB 6. The most diverse array of habitat types in a single reach was observed at HAY_MAIN_31 with a fairly even distribution of runs, riffles, pools, and frequent cascades with small sections of stills and backwaters.

The greatest diversity of habitat types within Slippery Creek was observed at TRIB10 and TRIB11 of Slippery Creek. These tributaries formed run-pool sequences with very little proportion of riffle. Nearly 90% of reaches throughout Slippery Creek featured 80% or more of ‘runs’.

The upper reaches of Waihoihoi Stream and forks 1 and 2 tended to have the greatest habitat diversity, within the Waihoihoi Steam, forming fairly even riffle, run, pool sequences. Some to moderate stable bank undercutting was also common through these reaches.

The upper reaches of the main channel of Symonds Stream and forks 1 and 2 had the greatest diversity of habitat on Symonds Stream forming riffle, run, pool sequences.

Nearly 70% of the catchment was considered to not have suitable fish spawning habitat present. Numerous reaches occur with instream and/or bank fish spawning habitat types present, however this is typically patchy, generally there is a lack of consistency of habitat provision between reaches. However, there are few sections within the catchment with

connected reaches that may have suitable fish spawning habitat. Some type of fish spawning habitat, as well as, some stable bank undercutting was identified along all reaches from HAY_MAIN_13 to HAY_MAIN_42 covering over 7 km of stream. Spawning habitat in this area typically included shaded low, grassed gravel to cobble floodplains, instream boulders, and woody debris (Figure 17).

Figure 17: Accessible floodplains on HAY_MAIN_25

Table 10: Summary of watercourse habitat diversity. Note that for bank undercutting the categories are defined by a percentage of the total reach length with undercutting present i.e. if there are 500m of reach with 'Good' undercutting then <50% of this total length is undercut. Refer to the methodology document for further details.

Attribute	**Mean**	**Min**	**Max**
Number of Habitat Types within reach	2.4	0	6
	In stream	**Bank**	**In stream & Bank**
Percentage of Reaches with Fish Spawning Habitat present	**12.1%**	**9.8%**	**8.3%**

	None	**Some**	**Moderate**	**Good**	**Extensive**
Stable Bank Undercutting (% of total stream length) (length of stream (m))	**52.5%** 45,766.8	**36.6%** 31,868.8	**9.9%** 8,594.5	**0.2%** 189.5	**0%** 0.0

3.2 Natural Structures

One hundred and thirty-six natural structures were identified within the Slippery Creek catchment during the stream assessment (Table 11). The majority of the structures comprised natural bedrock or boulders located near Hays Creek dam (HAY_TRIB6e_1) (Figure 18) and near the headwaters of Symonds and Waihoihoi Streams. Although 36 of the structures had unsafe drops, none of these require fencing due to their remote or difficult to access locations. See section 3.3.1 for fish passage issues.

Where the Drury fault line runs north to south through the Slippery Creek catchment, a series of natural structures (cascades and waterfalls) were located where each stream crosses over the fault line.

Figure 18: Bedrock cascade (HAY_TRIB6c_1).

Table 11: Natural structure safety risk matrix for structures recorded as 'Not safe' and 'Not safe, Drop >1.5m'.

Attribute				
Total number of natural structures		136		
		Access		
Not safe		Easy	Moderate	Difficult
Land Ownership	Public	0	0	1
	Private	0	5	4
Not safe, Drop >1.5m		Easy	Moderate	Difficult
Land Ownership	Public	0	0	1
	Private	0	12	13

3.3 Fish Survey

A total of six species of native fish were recorded from chance observations during the watercourse assessment and from electric fishing surveys at 10 SEV sites across the catchment. Fish observations and fish passage barriers within the catchment are shown in Map 6 Appendix A. Refer to section 4.3 for further information on SEV fish survey and IBI scores.

The majority of chance fish observations were located along Slippery Creek (Figure 19). Inanga were the most abundant native fish observed. Four schools of inanga were observed along the middle section of Slippery Creek (SLI_TRIB4_1 and SLI_MAIN_22, 24 and 30) approximately 4 km inland from the stream mouth. No inanga were recorded at any SEV sites. There were no inanga listed in the NZFDDB records between 2005 and 2015 (Figure 19).

Shortfin and longfin eels were captured at almost all SEV sites throughout the catchment. The greatest abundance of eels was captured at SC7 (SYM_MAIN_20) with 148 shortfin eels, most of which were <150 mm. Both longfin and shortfin eels were observed in the twi urban SEV sites (SC3 and SC4) to the north and south of the industrial sector.

The furthest upstream observation of banded kokopu was in a tributary of Hays Stream (HAY_TRIB6 – SC8), above Hays Creek dam were nearly 100 kokopu were captured. Two shortjaw kokopu were captured at SC9 (WAI_MAIN_22). The greatest abundance of longfin eel (8) and 24 large koura (>60 mm) were also observed at this site.

Common bully were also common in electric fishing records with 18-26 bullies captured in lower sites SC5, 6, and 7 ranging in size from 10-30 mm, whilst SC 3 and SC 2 had lower abundances (<6) of only larger individuals (30-40 mm).

High abundances of mosquitofish were observed along Slippery Creek. Mosquitofish were usually observed in schools, hiding under submergent or emergent macrophytes, such as willow weed. A single goldfish was also captured at SC3.

NZFDDB records in 1980 and 1995 include observations of torrent fish, common smelt, rudd and koi carp in the Slippery Creek catchment in addition to other species observed in the current survey.

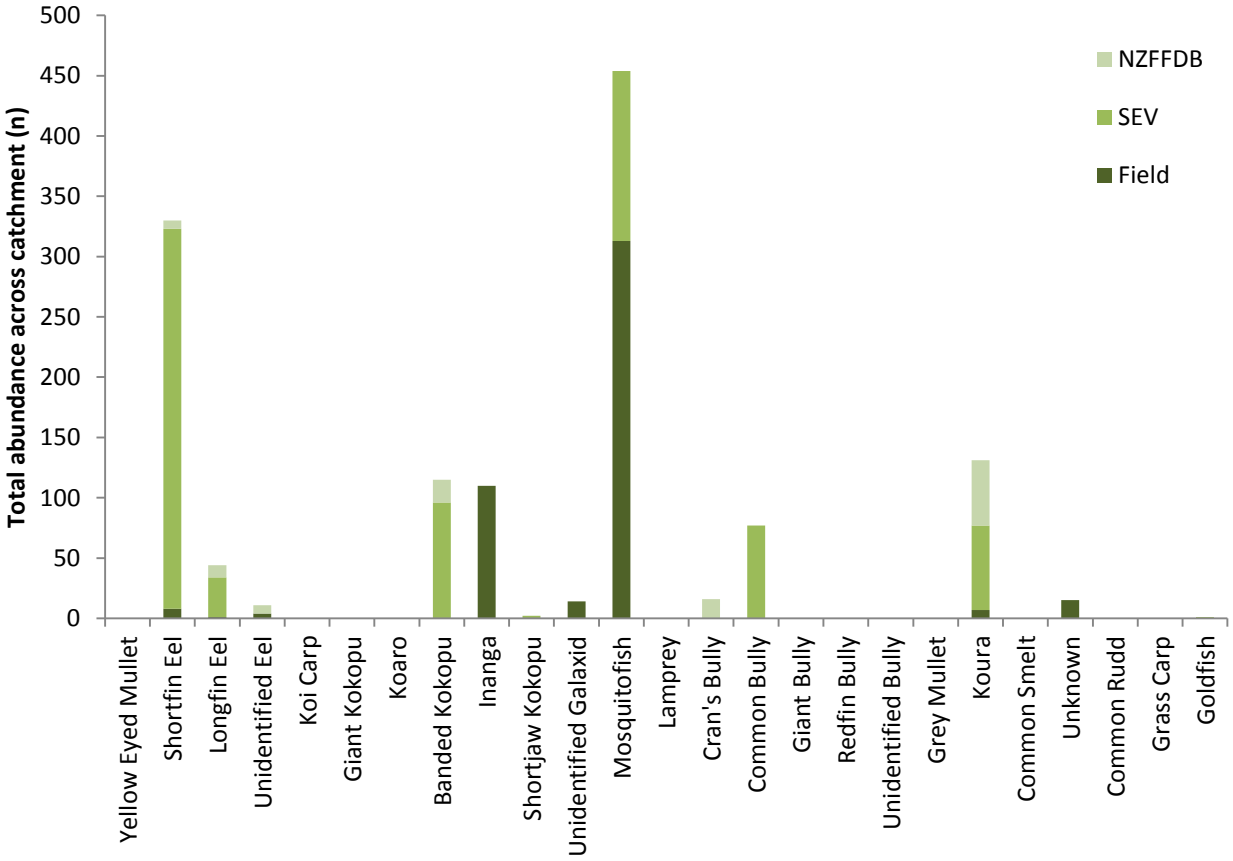


Figure 19: Fish species identified during the field survey and historically within the catchment from the New Zealand Freshwater Fish Database records from 2005. Where numerical abundances were not available in the NZFFDB the following abundance categories where used: R= ≤2, O= ≥3, C= >10 , A= >30.

3.3.1 Natural Barriers

All 136 natural structures observed were assessed for fish passage, the majority of these present at least a partial barrier to swimming species (Table 12). 35 natural structures were considered to present at least a partial barrier to climbing species, five of these formed complete barriers. The largest natural barriers to fish passage were three waterfalls on Waihoihoi and Hays Streams (WAI_TRIB2_23, HAY_MAIN_31 and HAY_TRIB8_1). These were considered to form a complete barrier to swimming and climbing species and a partial barrier to anguilliform species as there was no wetted connection to bypass the waterfalls. Shortfin and longfin eels, and banded kokopu were the only species observed upstream of the waterfall at HAY_MAIN_31. There was minimal upstream habitat above WAI_TRIB2_23 and HAY_TRIB8_1.

A series of cascades formed by willow roots were recorded as being a partial barrier to swimmers on the lower Waihoihoi, Symonds and Hays Streams (WAI_MAIN_2, WAI_MAIN_6, SYM_MAIN_5, HAY_MAIN_5, HAY_MAIN_12). No inanga were observed upstream of these barriers.

3.3.2 Artificial Barriers

Overall, 32 inlet or outlet structures were assessed for fish passage. These included only those structures where there was suitable upstream habitat, and did not include assets where only preliminary information was collected (if fish passage was an issue at any of these assets then an assessment would have been completed). Nineteen structures in total were considered to present at least a partial barrier to fish passage for swimming species, nine of which were also barriers to climbing species. Only one outlet structure (ID 1115847) was considered to present a temporary barrier to eels due to high flow.

A concrete apron (UNK_237) was recorded as being a complete barrier to swimmers on Symonds Stream (SYM_MAIN_19) as is it breaking up in places and the gabion baskets are beginning to slump into the stream (Figure 20). However, 26 common bully, which are typically considered to be poor climbers, were observed immediately upstream of this culvert at SC7.

Figure 20: Concrete apron at the outlet (UNK_237) on Symonds Stream (SYM_MAIN_19).

One hundred and forty-six culverts and pipes were assessed for fish passage, these included only those structures where there was suitable upstream habitat. None of the culverts or pipes assessed were fitted with specific fish passage devices.

Eighty-five pipes or culverts were considered to present at least a partial barrier to fish passage for swimming species. This was primarily due to the length of smooth pipe with high velocity flow, and insufficient resting areas, or insufficient water depth.

Fifty-seven of the total 85 pipe or culvert barriers were considered to present at least a partial barrier to climbers and 49 of these were located on private land. These barriers

were primarily due to the culverts being perched above the channel with no wetted margin or over hanging vegetation.

Fifteen of the total 85 pipe or culvert barriers were considered to present at least a partial barrier to all locomotory types. The majority of these were perched culverts and ten of these also required some kind of maintenance. Fourteen of these were located on private land, four were located in the upper reaches on Hays Stream (HAY_TRIB6f_6-9) and the majority of the remaining culverts were located along streams with less than 400 m of upstream habitat (HAY_TRIB6fl_3, HAY_TRIB6fl_2, HAY_TRIB4_3, SLI_MAIN_47, HAY_TRIB5_7).

Two dams were recorded as miscellaneous points on Hays Stream. One dam (HAY_MAIN_20; Figure 21) was recorded as being a complete barrier to all fish species whilst the other (HAY_TRIB6c_10) was a complete barrier to swimming species due to the drop at the broken apron and 5 m high spillway. However, six common bully, which are typically considered to be poor climbers, were captured upstream of this dam at SC2. Three weirs (HAY_TRIB6_1, WAI_TRIB2_25, SYM_MAIN_FORK2_13) were recorded as being complete barriers to swimming species.

Figure 21: Old dam infrastructure at HAY_MAIN_20 with broken concrete apron

Collectively, the following fish passage barriers may be considered priorities for remediation works as these barriers restrict fish passage to a large area of potential upstream habitat including approximately 9,604 m total stream length on Waihoihoi Stream and 10,947 m on Symonds Stream including the high quality upper forks of these streams. Additionally approximately 7 km of stream with good potential fish spawning habitat occurs upstream of these barriers from HAY_MAIN_13 to HAY_MAIN_42.

- a series of willow root cascades on WAI_MAIN_2, WAI_MAIN_6, SYM_MAIN_5, HAY_MAIN_5, HAY_MAIN_12;
- a cracked and broken culvert (UNK_205) requiring replacement (SYM_MAIN_12);
- the outlet structure at Ponga Road (UNK_237, SYM_MAIN_19); and,
- the dam at 244 Hunua Rd (HAY_MAIN_20).

Table 12: Fish passage and habitat features within the catchment.

Fish Barriers	Natural Structures	Engineering Assets (inlets and outlets)	Engineering Assets (culverts and pipes)
Fish Passage devices present	NA	0	0
Barrier to Swimmers	131	19	85
Barrier to Climbers	35	9	57
Barrier to Anguilliforms	5	1	15

3.4 Stream Mouths

The network of streams and associated tributaries within the Slippery Creek catchment including Slippery Creek, Waihoihoi Stream, Hays Creek and Symonds Stream drain to the Drury Creek arm of the Pahurehure Inlet in the Manukau Harbour. The tributaries drain via one main inlet of Slippery Creek. The area is a low energy receiving environment and is part of the marine Significant Ecological Areas SEA-M1-29b and SEA-M2-29a.

The upper limit of the stream mouth is marked by a change in vegetation observed upstream of the Highway 1 road crossing with a channel width of approximately 20 m. The upper area is within SEA-M1-29b and is considered vulnerable under the Proposed Auckland Unitary Plan. The area consists of mangroves and marshes and plays an important role as a marine and freshwater habitat migration corridor for native freshwater fish.

The lower reach of the stream mouth has an approximate channel width of 30 m and the upper boundary is characterised by the confluence with Drury Creek. The lower area of the stream mouth is within SEA-M2-29a. The area is characterised by mud intertidal flats and rocky reefs. The area is considered an appropriate roosting habitat for pied stilt.

Figure 22: Downstream of Slippery Creek at the confluence between Drury Creek and Whangapouri Creek

3.5 Inanga Spawning

Four areas of potential inanga spawning habitat were identified within the Slippery Creek catchment. All four areas were located in the lower reaches of Slippery Creek (SLI_MAIN_1 to SLI_MAIN_5). The first reach flows through public land where there is evidence of previous native riparian planting. The remaining lower reaches flow through private land, dominated by agricultural practices (see Table 13).

These reaches averaged 8-12 m wide with average banks heights of 0.1 to 0.4 m which are often inundated by high rainfall events. All areas were dominated by dense groundcover vegetation, namely *Glyceria* and pasture grasses with little overhead cover. Three areas were located on farmland, with stock access.

All areas have potential for enhancement. The three areas on farmland could be fenced off to prevent stock access and damage to the vegetation. All areas could be enhanced by planting native grasses and canopy species to provide bank stability and shade over the stream margins. Further investigation to identify the extent of the saline wedge at Slippery Creek should be conducted to facilitate the identification of suitable areas for spawning habitat enhancement.

Table 13: Total length of potential inanga spawning habitat (m)

Inanga Spawning	Sedge/Rush	Pasture	Park	Other
No potential for enhancement (or already enhanced and protected)	0	0	0	0
Potential for Enhancement	0	965	0	193

Figure 23: *Glyceria* dominated potential inanga spawning habitat.

3.6 Wetlands

Sixty-eight natural wetlands and 75 artificial wetlands/ponds were identified in the Slippery Creek catchment.

The majority of the natural, riverine wetlands observed in the catchment occur in the upper reaches of Hays Stream, Symonds Stream, and Waihoihoi Stream. Stream channels in the upper headwaters widen into a mixture of raupo and sedge/rush dominated wetlands with no clearly defined channel. In some areas it likely that damage to channel banks from stock has resulted in the riverine wetland form of these reaches (Figure 24).

Figure 24: Riverine headwater raupo wetland (UNK_077) with no defined channel and pugging from stock on both banks (HAY_TRIB6cl1_1).

Fifty-five of the artificial ponds were farm ponds, four were (wet) stormwater detention ponds and 15 were aesthetic ponds. All four of the stormwater detention ponds were located on Slippery Creek, in the urban area of the catchment. Stormwater quality ponds are the dominant form of stormwater treatment in this catchment. Major ponds include: Carisbrook Pond, Te Koiwi Pond, Berlane Place Pond, and, Crestview Pond

The largest 'wetland' recorded within the catchment was the Hays Creek Dam approximately 15,5131 m^2 which provides some of Auckland's water supply.

Channel modifications and farm pond construction or maintenance activities were commonly encountered. Several of these areas with recent earthworks were observed with no sediment or erosion control measures which contributes to downstream sedimentation issues. Details on five of these sites were communicated to Auckland Council promptly following field survey for further investigation if required. Many farm ponds also had moderate to severe erosion at the outlet points, in some instances leading to recent or imminent culvert failure, refer to sections 3.7 and 3.8 for more details. The largest farm

pond in the catchment (UNK_121) was approximately 2,617 m^2 located on Hays Stream (HAY_TRIB6k_3) in the bottom of a gully.

A farm pond (UNK_109) in the upper reaches of Symonds Stream (SYM_MAIN_FORK2_8) is providing important sediment retention for the downstream reaches of Symonds Stream (Figure 25). There is approximately 2,500 m of watercourse upstream of the pond and the dominant substrate type is silt/sand with most reaches having high sediment deposition. However, downstream of the pond, the dominant substrate is gravel and the reaches flow through mature native bush and provide suitable habitat for fish and invertebrates.

Figure 25: Farm pond (UNK_109) (SYM_MAIN_FORK2_8).

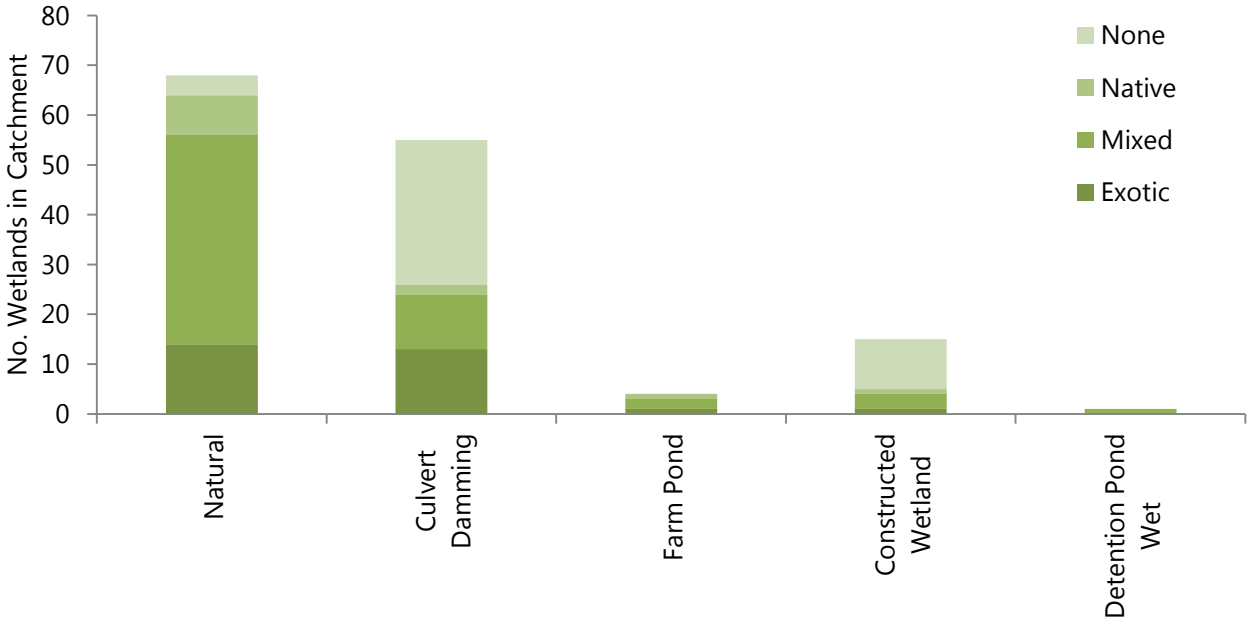


Figure 26: Summary of wetlands in the catchment area.

3.7 Engineering Assets (inlets, outlets)

An accurate understanding of the location of engineered assets is required to manage them effectively. Of the 666 assets surveyed:

- 418 were rural assets with no structural, erosion, or fish passage issues. As such, full surveys were not undertaken on these assets, only preliminary information was recorded.
- 248 assets were fully assessed. These assets were either in urban areas, under public roads, or on private land where issues such as fish passage or maintenance issues were observed. Of these assets:
    - 148 were were inlets or outlets, with no headwall, wingwall, or dissipating structures; and,
    - 100 were inlets or outlets with headwall, wingwall or dissipating structures.

A total of 68 assets could not be located and were therefore not surveyed. Nineteen of these assets were identified in GIS as being in close proximity to the watercourses but could not be located. The remaining 49 assets were not identified in GIS and were recorded as ‘could not locate’ where the inlet point was recorded but the outlet could not be accessed, or vice versa (in the case of culverts).

Most of the structures assessed were in good condition; only 7% of the structures assessed were in poor to very poor condition. Five of these assets were publically owned, however only three were recorded in Auckland Council GIS. These assets were functioning poorly due to damage or deterioration. In some cases, the structures had failed or were at risk of failing in the near future. The majority of these assets will likely require replacement.

A full summary of maintenance works required is provided in Appendix C. Refer to Appendix A Map 4 for an overview of asset locations and erosion issues.

Stormwater outfall 1116832 (pipe: 1136599) was identified as being in very poor condition. The headwall and wingwall structure associated with this asset appeared to have broken away from the pipe resulting in blockage of the pipe and slight erosion around the outlet. This asset requires replacement to restore its functionality.

Six percent of all inlet/outlet points in the catchment had moderate to severe erosion (44 assets); only four of these had a formal dissipating structure, eight others had some rock placement or other informal dissipation device. Fifteen of these assets were publically owned, however only four were recorded in Auckland Council GIS. In most cases, the strategic placement of rock around these assets would be sufficient to prevent further erosion from occurring. However, assets with larger diameters or steeper gradients where higher velocities are expected may require a headwall structure to be installed along with

adequate erosion protection. This type of remediation work may require further investigations and specific design.

Severe erosion was identified at stormwater outfall 1115574 (pipe: 1133644). The outlet was perched 3.5 m above the adjacent channel and no structure or any form of dissipation was present (see Figure 27). Erosion has caused the pipe to be undercut by approximately 1.5 m which has resulted in the vertical displacement of the last segment of pipe. Erosion protection works are required to prevent further erosion and undercutting of the pipe. Such works could include the reinstatement of the bank to normal ground level, installation of a headwall and wingwall structure and placement of rock down the bank from the outlet to the stream.

Figure 27: Severe erosion on HAY_MAIN_9 associated with asset: 1115574

Approximately 1% of assets in the catchment were identified as being ‘not safe’ or ‘not safe – drop 1.5m’. Most of these assets were in locations that were moderate or difficult to access. However, three easily accessible assets with unsafe drops >1.5 m high were located within public land on SLI_MAIN_30 at Kerry Downs Park (ID: 11115143, 1115144, 1115160). Safety fences should be installed around these outlets as per Auckland Councils standard specifications.

The outlets of farm ponds were commonly associated with moderate to severe erosion including ponds depicted below in Figure 28 to Figure 30 where severe erosion has resulted in the imminent failure, or failure of the culvert. As stated above, the majority of this erosion could be remediated through the placement of rock at the outlets. For the more severe cases, structures such as headwalls, wingwalls and aprons could also be installed.

Figure 28: High velocity discharge from wetland UNK_ 117 causing severe erosion downstream (SYM_TRIB2_10) (outlets UNK_379, UNK_380)

Figure 29: Severe erosion and culvert failure at HAY_TRIB6fl_2 (pond UNK_49, outlet UNK_581)

Figure 30: Recently installed culvert at HAY_TRIB6c_10 (wetland UNK_29, outlet UNK_414). A mature pine and the original concrete culvert had slipped.

Table 14: Summary of outlets, and inlets assessed over the surveyed extent.

	Assets Surveyed	Assets Correct in GIS	Assets Incorrect in GIS	Assets Not in GIS
Number of assets (inlets/outlets)	666	79	0	587 (418 prelim. only)

Condition Assessment	Very Good	Good	Average	Poor	Very Poor
Condition of structure	3	60	30	6	1

	None	Slight	Moderate	Severe
Extent of erosion associated with structures	157	43	36	8

	Replacement	Structural	Patching	Debris Removal	Vegetation Clearance	Erosion Protection
Maintenance required	1	5	5	1	2	9

Table 15: Engineering structure safety risk matrix for structures recorded as 'Not safe' and 'Not safe, Drop >1.5m'.

Not safe		Access		
		Easy	Moderate	Difficult
Land Ownership	Public	0	0	0
	Council	0	0	0
	Private	0	1	0
	Unsure	0	0	0
Not safe, Drop >1.5m		**Easy**	**Moderate**	**Difficult**
Land Ownership	Public	3	5	0
	Council	0	0	0
	Private	0	1	1
	Unsure	0	0	0

3.8 Engineering Assets (culverts, pipes)

Of the 401 culverts and pipes surveyed:

- 189 of these were private, assets on rural land with no structural, erosion, or fish passage issues. Only preliminary information was recorded for these assets (e.g. location, position, material, and photograph).
- 211 assets were fully assessed. These assets were either in urban areas, under public roads, or on private land where issues such as fish passage or maintenance issues were observed. Of these assets, 143 were culverts and 69 were pipes.

A total of 31 assets could not be located and were therefore not surveyed. Eighteen of these assets were identified in GIS as being in close proximity to the watercourses but could not be located. Thirteen culverts or pipes not identified in GIS were recorded as 'could not locate' as the assets were submerged or buried.

Forty-eight assets (culvert or pipes) were assessed that were correct in GIS. 145 assets were assessed that were not recorded in GIS (not including assets with preliminary information only recorded). Nineteen assets were assessed that were identified as being incorrect in GIS; this was generally due to the diameter or material being incorrect.

Approximately 17% of culverts and pipes in the catchment required some type of maintenance works, 30% of these (22 assets) were located on public land or under public roads. Erosion protection was the most common type of maintenance work identified; this was identified where erosion at the outlet point may compromise the structural integrity of the culvert or pipe. In most cases, the placement of rock around the assets would be an appropriate form of erosion protection. Additional investigations are required to determine the most suitable solutions for the more severely affected assets. A full summary of maintenance works required is provided in Appendix C.

Table 16: Summary of culverts and pipes assessed over the surveyed extent.

	Assets Surveyed	**Assets Correct in GIS**	**Assets Incorrect in GIS**	**Assets Not in GIS**
Number of Assets (pipes/culverts)	401	48	19	334 (189 prelim. only)

Condition Assessment	**Very Good**	**Good**	**Average**	**Poor**	**Very Poor**
Condition of assets	4	130	51	25	1

	Replacement	**Structural**	**Patching**	**Debris Removal**	**Vegetation Clearance**	**Erosion Protection**
Maintenance required	11	9	6	11	5	27

3.9 Bank and Channel Lining

The watercourse assessment undertaken in the Slippery Creek catchment identified 31 instances of bank and channel lining. Within the catchment approximately 415.5 m on the true right bank and 490.5 m of the true left bank have some bank lining or reinforcing (Table 17). The most common reinforcing was gabion baskets. Refer to Appendix A Map 3.

None of the bank or channel lining was considered to have a significant impact on stormwater flow, however, lining at five of these sites was considered to be in poor or very poor condition (Table 17). The sections of lining at these sites were functioning poorly due to damage or deterioration. In some cases, failure of the lining and risk of failure was identified. Further investigations should be undertaken to determine the extent of the deterioration and whether these sections of lining can be remediated or if replacement is required.

The bank lining on the true right bank of tributary WAI_MAIN_15 was in very poor condition and is located under a shared private driveway (Figure 31). The bank lining consists of a 5 m length of gabion baskets in which some sections have failed and have come away from the bank and fallen into the stream. The bank lining is also considered a risk to safety with a drop of larger than 1.5 m and moderate access (Table 18). Due to the extent of deterioration and the potential risk to the driveway, it is likely that this section of lining should be replaced and a safety fence should also be installed. However, this work would require further investigations and specific design.

Figure 31: Poor condition bank lining on WAI_MAIN_15 under shared driveway.

A section of poured in situ concrete bank lining on the true left bank of HAY_MAIN_29 was identified to be in poor condition (Figure 32). The bank lining was considered not safe with a drop larger than 1.5 m, however it is located alongside a major road (Hunua Road) with no defined pedestrian access. The bank lining was undercut by 1 m at the toe and may present a risk to the road and a nearby stormwater outlet (UNK_068). Reinforcement of the existing bank lining could be undertaken by filling the undercut area with rock. However, further investigations would be required to determine the best option for remediation.

Figure 32: Undercut bank lining on HAY_MAIN_29

Thirteen bank or channel linings were assessed as ‘Not Safe Drop >1.5 m’. Five of these were considered easily accessible to the public and located on tributaries HAY_MAIN_25, SLI_MAIN_1 and SLI_MAIN_30. These locations should be further investigated with the recommended outcome being safety fences installed along these five lengths of bank and channel linings.

Table 17: Summary of bank lining assessed over the surveyed extent. Note that the condition assessment is based on the overall condition of the lining, where both banks or channels are lined these are not assessed separately.

Physical Factors					
Total Length of Surveyed Watercourse (m)			87,179.3		
No. Reaches			604		
Total Length of Bank Lining (m)			906*		
Total Length of Channel Lining (m)			117.5		
	Mean		**Min**		**Max**
Bank Height (m)	1.3		0.5		2.4
Length of bank lining (m)	21.2		3.5		90
Length of channel lining (m)	25.2		1.5		90
Condition Assessment	**Very Good**	**Good**	**Average**	**Poor**	**Very Poor**
Condition of bank lining (% of total bank lining length) (length of lining (m))	**1.8%** 12.0	**52.7%** 346.0	**36.6%** 240.0	**8.1%** 53.0	**0.8%** 5.0
Condition of channel lining (% of total channel lining length) (length of lining (m))	**10.2%** 12.0	**81.7%** 96.0	**8.0%** 9.5	**0%** 0	**0%** 0
	Not Significant		**Significant**		**Critical**
Impact on Stormwater Flows (% of total bank and channel lining) (length of lining (m))	**100%** 656		**0%** 0		**0%** 0

* Note that were both banks are lined the total lining length is doubled.

Table 18: Bank lining safety risk matrix for structures recorded as 'Not safe' and 'Not safe, Drop >1.5m'.

Not safe		**Access**		
		Easy	**Moderate**	**Difficult**
Land Ownership	Public	0	0	0
	Private	1	0	0
Not safe, Drop >1.5 m		**Easy**	**Moderate**	**Difficult**
Land Ownership	Public	3	2	1
	Private	2	4	1

3.10 Erosion Hotspots

There were 33 erosion hotspots observed within the Slippery Creek catchment that meet the definition outlined in the Watercourse Assessment Methodology 2.0.

An erosion hotspot is defined as:

- Severe erosion located within the channel and/or lower or upper banks resulting in slumping and/or exposed soil surfaces.
- The hotspot must also:
    - exceed two metres in length and/or have a total surface area of disturbed soil >5 m^2; and,
    - be actively eroding; and,
    - be detrimental to stream health and/or causing significant and/or immediate safety or infrastructure concerns.

The majority of erosion hotspots observed had poor overall bank stability within the 10 m upstream of the hotspot (Table 20). Erosion hotspots were commonly observed on the outside of meanders where banks were sheer and typically 2 m high on the outside of the meander, and considerably lower, approximately, 0.6 m high on the inner corner. These reaches also typically had no riparian vegetation and other areas of mass wasting or other erosion hotspots were nearby. All erosion hotspots were located on privately owned land. Refer to Appendix A Map 4 for a summary of erosion issues including locations of erosion hotspots.

Fifteen, hotspots were located on Waihoihoi Stream, with the majority of these upstream of the tributary WAI_MAIN_9. These erosion hotspots continued upstream of WAI_MAIN_9 approximately 1 km with hotspots every 50-100 m.

One erosion hotspot was identified on WAI_MAIN_11-12, within 10 m of a residential dwelling which was considered to present a moderate risk to the dwelling (Figure 33). Approximately 40 m^2, had undercut the fence of a property as well as a small bridge crossing. Ongoing erosion could cause the fence to collapse into the stream, and further investigation by a geotechnical engineer is recommended to define the nature and extent of any remediation works at this site. Works could include reinstating the bank to a more suitable grade, planting and installing rock at the toe of the bank for erosion protection. However, further investigations and specific design is required to ensure the most suitable option is implemented.

The largest erosion hotspot assessed (180 m^2) was located along the true right bank of WAI_MAIN_13 on privately owned rural farm land (Figure 34). Although healed in some parts, the area included fresh erosion with mass wasting and unstable overhanging banks Ongoing erosion at this site is likely. Previous straightening of the stream channel has occurred along these reaches; it is likely that some of the erosion could have been caused

by the streams propensity to meander. Thus, remediation options could include naturalisation of the stream channel to include meanders as well as regrading and planting of the banks (see enhancement opportunity 6 in section 5.2).

Nine disconnected erosion hotspots were assessed along Symonds Stream between SYM_MAIN_20 and SYM_MAIN_22 (Figure 35). Eight of these hotspots were considered to have poor upper bank stability due to high banks and steep bank angles, and poor riparian vegetation. Risk to buildings was identified as low to none as the reaches are through rural farm land. As such, regrading and planting of the banks may be a suitable option for remediation. Further details are provided in enhancement opportunity 5 in section 5.2.

Table 19: Summary of erosion hotspots.

Attribute				
Total Length of Surveyed Watercourse (m)		87,179.3		
No. Reaches		604		
Total Length of Erosion Hotspots (m)		555.5		
Total Area of Erosion Hotspots (m^2)		1164.4		
Total Number of Erosion Hotspots		33		
	Mean	**Min**	**Max**	
Length (m)	16.8	5.0	90.0	
Bank Height (m)	1.5	0.2	4	
Area (m^2)	35.3	6.5	180.0	
	Access			
	Easy	**Moderate**	**Difficult**	
Land Ownership	Public	0	0	0
	Private	2	31	0

Table 20: Summary of Pfankuch bank stability assessment of the 10m upstream of erosion hotspots.

	Excellent	**Good**	**Fair**	**Poor**
Land Slope	0	0	2	31
Mass Wasting	0	1	5	27
Debris Jam	7	8	8	10
Bank Vegetation	1	1	6	25
Overall Stability Index (% of total length) (length of stream (m))	**0%** 0	**1.0%** 5.5	**20.7%** 115	**78.0%** 435

Figure 33: Erosion hotspot on WAI_MAIN_11/ WAI_MAIN_12

Figure 34: Erosion hotspot on WAI_MAIN_13

Figure 35: Erosion hotspots on SYM_MAIN_20 and SYM_MAIN_1

3.11 Miscellaneous Points

Refer to Appendix A Map 8 for an overview of key miscellaneous features.

3.11.1 Discharges

One hundred and ninety reaches were recorded as having at least one discharge along their length including:

- 132 tributaries connecting to watercourses that were not identified for survey;
- One groundwater seepage from a recently cleared and sprayed bank (SLI_MAIN_23);
- One pollution incident involving sewage fungus found in a 225mm pipe draining into a small stormwater pond (SLI_MAIN_38);
- Three springs;
- 46 stormwater discharges; and'
- Seven other discharges,

Of the seven 'other' discharges, four of these involved foam in the stream at the base of private stormwater drainage pipes. There were two instances of the stream extending beyond the survey map on Waihoihoi Stream and one instances of pollen scum located at SLI_TRIB7_2. None of the discharges were assessed as significant to stormwater flows.

3.11.2 Engineering

One hundred and twenty-three miscellaneous engineering points were recorded within the Slippery Creek catchment including:

- Five dams;
- 40 debris jams;
- One flap valve;
- 14 pipe bridges;
- 49 private stormwater or drainage pipes (<225 mm diameter);
- Eight weirs; and,
- Six other features.

One debris jam was considered to present a significant impact to stormwater flows as it had the potential to flood non-habitatable, recreational land (Figure 36). This consisted of tree debris and rubbish accumulating in a narrow part of the channel. This site can be easily accessed and therefore clearance of the jam is required to prevent further buildup of debris and any potential flooding of the adjacent park.

Figure 36: Debris jam obstructing flood flow caused by a shopping trolley on SLI_MAIN_31 at Keri Downs Park

3.11.3 Other

One hundred and sixty-eight other miscellaneous points were recorded within the Slippery Creek catchment. This included:

- Four access points;
- 69 bridges that were used for pedestrian, vehicles or farm use;
- 38 landslides or slips;
- Seven areas of litter dumping, four of which were located on Hays Stream;
- Seven man-made fords used as farm vehicle crossings,
- One significant tree, a mature Puriri tree (WAI_TRIB2_23);
- Three areas of significant vegetation;
- Two wildlife sightings (a possum in a tree on HAY_TRIB3_4 and a weka call from a bush on HAY_TRIB6eI_2); and,
- 37 other miscellaneous features.

The majority of the landslides or slips identified were located on reaches with >20% bank erosion on one or both banks and indicate particulars areas of the reach that are the worst affected. Eighteen landslides or slips were located on Symonds Stream and the remainder were spread across Slippery Creek, Hays Stream and Waihoihoi Stream.

Nine landslides or slips were assessed within the reaches of SYM_MAIN_4 to SYM_MAIN_9 (Figure 37).

Figure 37: Land slips on SYM_MAIN_5 and SYM_MAIN_9

One of the other miscellaneous points was assessed as significant to stormwater flow. The point was collected at SLI_TRIB5_7 and consisted of a wire mesh fence with debris accumulation (Figure 38). The debris build up was restricting flow and has a potential to flood a non-habitable informal recreational area. The debris should be removed from this site; modification to the existing fence may also be required to ensure this site does not accumulate further debris in the future.

Figure 38: Wire mesh fence with debris build up potentially restricting flow on SLI_TRIB5_7

4.0 SEV's and Additional Variables

4.1 In-Stream and Riparian Habitat

4.2 Stream Ecological Valuation Assessment

Introduction

A total of ten Stream Ecological Valuations (SEV's) were undertaken within the Slippery Creek catchment from 15th April to 22nd April 2015. SEV sites across the catchment were selected in accessible areas; representative of upper, middle and lower points within the catchment, in urban, and rural land uses. A summary of scores is provided in Table 21 and a representative photo of each reach is provided in Figure 39. Refer to Appendix A – Map 1 for SEV locations and Appendix B for detailed SEV scores.

Of the 10 sites, four sites received overall scores within the 'high ecological value range' (above 0.8). The remaining eight sites received overall scores between 0.406 and 0.665, within the 'moderate' range (0.3 - 0.7).

A previous report in the Slippery Creek and Papakura catchments was written in 2006 to address the 'Stream Management' component of the Integrated Catchment Management Plan developed by Papakura District Council (Phillips *et al.,* 2006). The survey involved undertaking 18 SEVs. Five of these sites were surveyed again in this study to compare changes in the SEV scores over the last nine years.

Highest Scoring Streams

The four highest scoring sites were SC1 (0.832), SC2 (0.804), SC9 (0.853) and SC10 (0.865). These sites were located on Hays, Waihoihoi and Symonds Streams under mature or regenerating native bush.

The limiting characteristics of SC1, SC9 and SC10 were in habitat provision functions, namely aquatic habitat diversity. Both SC9 and SC10 had limited woody debris and SC9 had less overhead cover, with mostly kanuka forest and the vegetation had not fully matured. SC1 was located in the upper catchment along Hays Stream. SC1 had shallow flow and a high sediment load, which could potentially be a result of feral pigs browsing along the stream edge causing pugging and erosion. SC2 is located further downstream from SC1 along Hays Stream and was limited by biodiversity provision functions, namely fish fauna intact. This is potentially due to the absence of woody debris in the stream despite a mature, intact margin on both banks.

A previous SEV survey of SC1 in 2006 (Phillips *et al.,* 2006) received an overall SEV score of 0.760. The overall score was higher in 2015 with the largest differences being in hydraulic (0.82 in 2006) and biogeochemical (0.69 in 2006) functions. However the 2006

biodiversity provision score (0.81) was higher than this survey (0.72) due to a much lower fish IBI score in 2015 (36) compared to the previous assessment (52).

Lowest Scoring Stream

SC4 received the lowest overall SEV score of 0.406. This reach was characterised by a narrow channel surrounded by turf in Keri Downs Reserve with mature amenity poplars providing scattered shade. The site was situated in the mid to upper reaches on Slippery Creek (SLI_MAIN_31) surrounded by urban land use. The limiting characteristics of SC4 were biodiversity and habitat provision. The mowing of the riparian margin up to the edge of the stream is causing a significant input of organic material (grass clippings). High emergent macrophyte growth including *Glyceria sp.*, willow weed, false watercress, and oxygen weed is also evident.

In a previous SEV survey undertaken in 2006 (Phillips *et al.,* 2006) this same site scored an overall SEV score of 0.420. This shows a minor decrease in the overall score with the largest differences being in habitat provision and biogeochemical functions. This score could be improved by ceasing mowing to the edge of the stream and planting along the stream to stabilise the banks and provide more shade (refer to enhancement opportunity 1 in section 5.2.for further details).

Urban Streams

Two SEV sites were located within the urban area of the catchment including the lowest scoring site (SC4). The other site is SC3 which received an overall SEV score of 0.665. SC3 was characterised by willows along both banks affecting the hydrology of the stream and causing an increase in roughness from the submerged and surface reaching macrophytes and willow roots.

SC3 was also previously assessed in 2006 resulting in a higher overall score of 0.790.. The largest difference was due to lower biodiversity function scores. The site received 0.83 for biodiversity in the 2006 survey and in this survey the site received 0.41, this was partly due to a large difference in fish IBI scores (44 in 2006 compared to 24 in 2015). In 2006 crans bully, banded kokopu, inanga, longfin and shortfin eels were observed, in comparison with common bully, longfin and shortfin eels and a goldfish observed in this survey. It is possible that natural barriers downstream of SC3 formed by willows may be restricting passage for inanga.

Rural Streams

Eight SEV sites were located within rural areas in the catchment, which dominates the land use in the Slippery Creek catchment. The four highest scoring sites were located in this area and the remaining four sites scoring between 0.500 and 0.636

SC6 (0.500), SC5 (0.513), and SC7 (0.546) were situated in similar positions within the lower catchment. SC6 was characterised by willows along both banks, affecting the

hydrology of the stream. SC5 was characterised by a low floodplain connectivity, erosion and bank slumping and excessive macrophyte growth.

SC5 and SC7 were previously surveyed in 2006 and received an overall score of 0.57, and 0.580 respectively, demonstrating a slight decline at both sites (Phillips *et al.,* 2006). As noted in the 2006 report, SC7 was located in a grazed property with considerable bank erosion and a limited riparian margin.

SC8 scored 0.636 and was located in the upper catchment with a road along the TLB and a vineyard on the upper TRB. Limiting characteristics of this site were in habitat provision due to the absence of boulders and large cobbles and unsuitable galaxiidae spawning habitat due to no connection with the floodplain.

Table 21: Summary of mean SEV scores across sites.

Site Code	Trib code	Hydraulic	Bio-geochemical	Habitat Provision	Biodiversity	Total SEV Score
SC1	HAY_TRIB4_2	0.94	0.87	0.67	0.72	**0.832**
SC2	HAY_MAIN_29	0.95	0.85	0.85	0.50	**0.804**
SC3	HAY_MAIN_12	0.82	0.66	0.76	0.41	**0.665**
SC4	SLI_MAIN_31	0.66	0.37	0.21	0.26	**0.406**
SC5	SLI_MAIN_17	0.65	0.62	0.38	0.25	**0.513**
SC6	WAI_MAIN_6	0.67	0.52	0.33	0.36	**0.500**
SC7	SYM_MAIN_20	0.74	0.53	0.44	0.39	**0.546**
SC8	HAY_TRIB6_5	0.74	0.76	0.41	0.44	**0.636**
SC9	WAI_MAIN_21	0.95	0.87	0.94	0.65	**0.853**
SC10	SYM_MAIN_2	0.98	0.94	0.96	0.52	**0.865**

SC1

SC2

SC3

SC4

SC5

SC6

SC7

SC8

SC9

SC10

Figure 39: Representative photo of each SEV site surveyed in the Slippery Creek catchment

4.3 Biodiversity

Macroinvertebrate Community Index (MCI) scores

The highest MCI score was recorded at SC1 (125.44) which was within the 'excellent' range indicative of streams with high water quality. SC1 is a soft bottomed stream in the upper tributaries of Hays Stream.

The second highest score was recorded at SC9 (103.33), on Waihoihoi Stream. This site was hard bottomed andthe greatest diversity of EPT taxa was observed at this site however, this was inclusive of some EPT taxa with greater tolerances to poor water quality such as the caddisfly *Oxyethira* sp. The three lowest MCI scores were recorded at SC4, SC5 and SC10, which were all within the 'poor' range (Table 22). The lowest score was recorded at SC4 (68.24) which also received the lowest overall SEV score. No EPT taxa were present at this site.

The site with the highest overall SEV score (SC10) had the second lowest MCI score (76.67). A limiting characteristic of this site was the lack of woody debris in the stream which provides valuable habitat for macroinvertebrate fauna.

Fish IBI scores

All ten sites were surveyed using the electric fishing method. The most recent data in the Slippery Creek catchment from the NZFFDB is from 2005. Four of the surveyed sites had data from 2005, the next most recent data was from 2002.

Species observed from electronic fishing included; shortfin and longfin eel (*Anguilla australis, A. dieffenbachii*), shortjaw kokopu, banded kokopu and inanga (*Galaxias posvectis. G. fasciatus, G. maculatus*), crans and common bullies (*Gobiomorphus basalis, G. cotidianus*), and the exotic species mosquitofish (*Gambusia affinis*) and goldfish (*Carassius auratus*).

Shortjaw kokopu are relatively rarely encountered and the protection of water bodies occupied by shortjaw kokopu is a priority for the conservation of this species (DoC, 2005).

The lowest IBI score was recorded at SC2 (16) which was within the 'very poor' range (Table 23). The only fish recorded at this site were common bullies. Sites upstream, SC1 and SC8, located at high altitude upstream of SC2, scored 36 and 40 respectively due to the presence of banded kokopu and shortfin eel which places these sites within the 'good' range. It is possible that fish diversity at SC2 is limited by downstream fish passage barriers as this site had a high overall SEV value.

The six SEV sites in the lowland rural and urban areas scored between 20 and 26 placing these sites within the 'poor' range. The most diverse site was SC3 on Hays Stream with both shortfin and longfin eel, and common bullies. Longfin and shortfin eel were present within SC4 despite the low overall SEV and MCI scores at this site.

No common smelt were observed during the field survey or electric fishing. Historic records from 1980 show these were found in the lower parts of the catchment along Waihoihoi and Hays Streams.

Table 22: Quality thresholds for interpretation of MCI (Stark *et al.* 2004).

Quality	Description	MCI score
Excellent	High quality, well shaded, clean water.	>120
Good	Mild pollution	100-120
Fair	Moderate pollution	80-100
Poor	Severe enrichment	<80

Table 23: Attributes and suggested integrity classes for the Index of Biotic Integrity: Fish

Total IBI score	Integrity class	Description
42 – 60	Very Good	Comparable to the best situations without human disturbance; all regionally expected species for the stream position are present.
36 – 41	Good	Species richness and habitat or migratory access reduced, site shows some signs of stress.
28 – 35	Fair	Some stressors present, biotic integrity impaired.
18 – 27	Poor	Species richness is drastically reduced biotic integrity harmed. Habitat and or access is impacted.
1 – 17	Very poor	Impacted or migratory access almost non-existent.
0	No native fish	Site is grossly impacted or access non-existent.

Table 24: Summary of biodiversity index values across sites.

Site Code	MCI-sb or hb	No. Taxa	EPT Taxa	Fish IBI Scores
SC1	125.44	18	6	36.00
SC2	86.67*	24	9	16.00
SC3	87.06*	17	4	26.00
SC4	68.24	17	0	26.00
SC5	67.67	12	2	20.00
SC6	99.89	19	2	20.00
SC7	90.77*	26	10	26.00
SC8	86.67*	18	6	40.00
SC9	103.33*	18	11	38.00
SC10	76.67*	12	1	22.00

* Sampled using the hard bottomed protocol, all others are soft bottomed sites

4.4 Sediment Chemistry

Two of the 10 SEV sites exceeded heavy metal ISQG – low trigger values for at least one contaminant (Table 26). SC3 exceeded this threshold for zinc and SC4 exceeded the limits for both lead and zinc. ISQG – low trigger values are the single contaminant thresholds where adverse biological effects could occur as an early warning for management intervention. ISQG – high trigger values are indicative of the contaminant concentrations where significant biological effects are expected. No sites exceeded these values for any of the heavy metals or PAH.

As mentioned above, heavy metal concentrations at SC4 exceeded the low trigger value for zinc and lead. This site was located in a residential area and thus high heavy metals may be attributed to untreated zinc roofs.

Concentrations of zinc and copper more than doubled at two sites, SC3 and SC4 compared to previous sampling conducting in 2006 (Phillips *et al.* 2006) (Table 25). It is possible that this may be due to increased development in the area and further investigation is recommended which could include more detailed catchment analysis. It is interesting to note that the other three sites (SC1, SC5 and SC7) all had slightly lower concentrations of both copper and zinc than in the 2006 survey.

Table 25: Heavy metal concentrations at sites previously surveyed in 2006 compared to results from the present survey (2015).

Site	2006 Concentrations (mg/kg/dry wt)			2015 Concentrations (mg/kg/dry wt)		
	Zn	Cu	Pb	Zn	Cu	Pb
SC1	60	18.7	NA	56	14	20
SC3	74.6	18	NA	**360**	**44**	27
SC4	88.4	7.9	NA	**210**	**18**	123
SC5	126	9.5	NA	117	7	10.9
SC7	78.2	14.9	NA	69	12	13.4

Table 26: Summary of sediment contaminants

	Zn	Cu	Pb	Total PAH
No. sites ANZECC >ISQG-Low	2	0	1	0
No. sites ANZECC >ISQG-High	0	0	0	0

4.5 Public Health

SC3 and SC6 exceeded the 2014 National Policy Statement for Freshwater Management (NPSFM) National Bottom Line for *E.coli* (Table 27). This corresponds to a high risk of infection from contact with water during activities with occasional immersion or ingestion of water e.g. wading and boating. SC3 is difficult to access and has industrial buildings along the TRB and agricultural practices on the TLB and further upstream. It is likely that bacterial contamination may be attributed to runoff from agricultural practices further upstream. Further monitoring is required to determine the source of *E.coli* at this site and inform future management.

SC5 scored within category C indicating a moderate risk of infection from contact with water during activities with occasional immersion and some ingestion of water e.g. wading and boating. This is a rural site and it is likely that bacterial contamination may be attributed to stock access further upstream.

The remaining seven sites were within the 2014 NPSFM minimum acceptable levels for contact recreation.

Water quality assessments undertaken in the 2006 survey of the Slippery Creek catchment found some similarities with sites that were assessed in this survey. *E.coli* results exceeded the NPSFM National Bottom Line for *E.coli* at sites located where SC3, SC5 and SC7 are located. SC7 had a significant amount of *E.coli* in 2006 (1,382 cells/100 ml), but only 420 cells/100 ml for this survey. This reach has stock access along both banks but minor damage was observed at the time of this survey.

Table 27: Summary of *E.coli* levels

	A	B	C	D
No. sites in Microbial Assessment Categories (sample 95th percentile)	4	3	1	2

4.6 Summary

Of the ten sites, four sites received overall scores within the 'high ecological value range' (above 0.8). The remaining eight sites received overall scores between 0.406 and 0.665, within the "moderate' range (0.3 - 0.7).

The high scoring sites were located in the upper catchment, under native regenerating or mature bush. The limiting variables of the lower scoring sites were namely riparian vegetation intactness, habitat diversity and bank erosion.

Two sites scored above the ISQG tolerance levels for heavy metals one of which also had *E.coli* concentrations above the National Bottom Line for recreational contact with water. A third site also exceeded the National Bottom Line for recreational contact with water. Further investigation may be considered to identify sources of *E.coli* at locations that did not meet the National Policy Statement for Freshwater National Bottom Line.

Opportunities to improve SEV scores in the Slippery Creek catchment include fencing off streams in grazed paddocks and undertaking riparian planting.

5.0 Watercourse Management

5.1 Management Zones

Eleven management zones have been identified for the Slippery Creek catchment based on reaches with similar pressures and issues. General maintenance issues and possible management objectives have been provided for each zone. The stream reaches included within each zone and enhancement opportunities present are summarised below in Table 28 and displayed in Appendix A Map 7.

An opportunity exists to implement 'greenways' design concepts to develop riparian corridors that offer alternative transport connections and informal recreational space. This would help to address one of the six key goals of the Papakura Local Board; for Papakura to be a well-connected area that is easy to move around. The total length of the proposed cycle loop track is approximately 9.5 km and aims to provide alternative transport options and improve connectivity to key recreational and transport infrastructure such as the Opaheke Sports Park and the Papakura Park and Ride.

Table 28: Management Zone summary.

Management Zone (MZ)	Location/Stream Reaches	Enhancement Opportunities
1 Future Urban – Erosion Risk	SLI_MAIN_1-10 SLI_TRIB1-TRIB3 SYM_MAIN_1-23 SYM_TRIB1 SYM_TRIB2_1-6 WAI_TRIB1 WAI_TRIB2_1-11 WAI_MAIN_1-18 WAI_TRIB2a-TRIB2b WAI_TRIB7_1-3 WAI_TRIB7a_1 WAI_TRIB3-TRIB6	EO 5 EO 2 EO 6
2 Opaheke Sports Park and Bellfield Development	SLI_MAIN_11-17 SLI_TRIB4	
3 Croskery Drain Industrial Sector	SLI_MAIN_23-30 SLI_TRIB7-TRIB8	EO 2
4 Industrial Sector Southern Border – Hays Stream	SLI_MAIN_18-19 HAY_MAIN_1-15 HAY_TRIB1-TRIB2	EO 8
5 Urban Open Space	SLI_MAIN_20-22 SLI_MAIN_31-32 SLI_TRIB-TRIB6	EO 8 EO 1

Management Zone (MZ)	Location/Stream Reaches	Enhancement Opportunities
6 High Land Rural Lifestyle – Slippery Creek	SLI_MAIN_33-47 SLI_TRIB10-TRIB13 SLI_TRIB9_6-12	EO 2
7 High Land Rural Lifestyle – Symonds and Waihoihoi Streams	SYM_TRIB2_7-15 SYM_TRIB3_2-3 WAI_TRIB2_12-27 WAI_TRIB7_4-7 WAI_TRIB7a_2-3	EO 3 EO 9
8 High Value Indigenous Forest	HAY_TRIB4_1-2 HAY_TRIB5_9 HAY_TRIB6a HAY_TRIB6c_1 HAY_TRIB6d Upstream of SYM_MAIN_23 except those that are in MZ 1, 6 and 9 Upstream of WAI_MAIN_19	
9 Agricultural Headwaters – Pine Plantations	HAY_TRIB6c_2-3 HAY_TRIB6eI_1-2 HAY_TRIB6f_1-3 HAY_TRIB6fI_1 HAY_TRIB6g HAY_TRIB6j_8-9 HAY_TRIB6kI_3-4 SYM_MAIN_FORK2_8 SYM_MAIN_FORK2_16-17 SYM_MAIN_FORK2_TRIB3_1 SYM_MAIN_FORK2_TRIB5_3-4 SYM_MAIN_FORK2_TRIB7_1	
10 Hunua Gorge	HAY_MAIN_16-38 HAY_TRIB3 HAY_TRIB5_1 HAY_TRIB6	
11 Agricultural Headwaters - Pastoral	Upstream of HAY_TRIB6 except those that are in MZ 1 and 8 SYM_MAIN_FORK2_9-19 SYM_MAIN_FORK2_TRIB4_1 SYM_MAIN_FORK2_TRIB5_1-2 SYM_MAIN_FORK2_TRIB7_2 SYM_MAIN_FORK2_TRIB8	

5.1.1 Management Zone 1 – Future Urban, Erosion Risk

The low lands west of the Drury fault line are currently rural, predominantly used for cattle grazing. The main channels of Symonds Stream and Waihoihoi Stream pass through this area before their confluence with Slippery Creek. The 7.35 km^2 area is zoned as 'Future Urban' under the Proposed Auckland Unitary Plan (refer to Appendix A Map 2). This zone applies to land that will be urbanised within the next 30 years, and in the interim, will continue to be used for rural purposes. The zone restricts subdivision in order to ensure that future development of these areas is structured comprehensively. A structure plan change will be required to change this zoning to urban use. SYM_MAIN_21 to 23 fall outside of the 'Future Urban' zone however due to the underlying geology, stream morphology, and susceptibility to erosion, these reaches should be addressed in conjunction with the downstream reaches of Symonds Stream.

The following management recommendations include remedial works to target existing erosion issues with the zone on shorter time frames whilst rural land practices preside, and recommendations to be considered in future structure plan(s) development. All short term goals and maintenance issues will require collaborative engagement with land owners. All water sensitive design recommendations and erosion issues require particular attention in structure plan development to mitigate any increase in pressure on downstream reaches from an increased area of impervious surfaces as there are currently no Stormwater Management Area - Flow (SMAF) zoning rules in place within this management zone.

SC6 on the lower Waihoihoi Stream (WAI_MAIN_6) downstream of the confluence between Waihoihoi and Symonds Stream exceeded the National Policy Statement for Freshwater Management (NPSFM) National Bottom Line for *E.coli*. It is likely that this is attributable to faecal contamination from stock access to streams.

General maintenance issues within this Management Zone:

- Ten inlet or outlet structures within this zone have some kind of damage or erosion requiring maintenance.
    - Two public outlets require structural patching: UNK_176 at Appleby Rd (inlet structure also requires patching), and, UNK_237 on Symonds Stream under Ponga Rd which also fish passage improvements.
    - One public outlet (UNK_374, pipe UNK_212) on Symonds Stream requires vegetation clearance to clear obstruction from willow roots contributing to flooding on Ponga Rd.
    - Five other private structures require maintenance including: structural patching (UNK_408), moderate erosion issues (UNK_550, 250,148,140)
- One erosion hotspot within this zone on WAI_MAIN_11-12 presents a moderate risk to a residential property due to undercutting of the fence and a small bridge.

Suggested goals and objectives for the Management Zone are to:

- Contact landowners to provide education regarding management of waterways, landowner responsibilities, and supporting programmes and funding such as the Environment Initiatives Fund, or Trees for Survival.
- Future proof channels through erosion susceptibility mitigation works.
- Manage willows to reduce erosion from flow diversion, debris jams, and improve fish passage to upstream high value habitat.
- Investigate lower reaches of the main channel of Slippery Creek for potential inanga spawning habitat and potential for enhancement.
- Upgrade and install all required inlets and outlets to appropriate inlet outlet standards including: TR2013-18 (Hydraulic Energy Management Inlet Outlet Design for Treatment devices); GD2015/004 (Water Sensitive Design for Stormwater); SWCoP 2015 (Auckland Council Stormwater Code of Practice for Land Development and Subdivision).
- Protect and enhance areas with remnant mature indigenous trees particularly at WAI_MAIN_6, SYM_MAIN_7, SYM_MAIN_14-16.
- Retain existing stream meander patterns and avoid any further channel straightening.
- Engage landowners to fence watercourses where moderate to severe stock damage has occurred to reduce further damage and ongoing sediment and faecal pollution downstream.

Suggested goals and objectives for structure plan development within the Management Zone are to:

- Establish 40 m wide riparian corridors with a minimum width of 10 m on each bank on the main channels of Symonds Stream and Waihoihoi Stream, and tributary 5 of Waihoihoi Stream. Planting should be conducted on stream margins, banks and floodplains.
- Integrate bioengineering to increase habitat values for fish.
- Increase channel sinuosity between WAI_MAIN_12 and WAI_MAIN_18
- Incorporate shared cycle/walkways along riparian corridors to improve connectivity to key recreational and transport infrastructure such as the Opaheke Sports Park and the Papakura Park and Ride.
- Integrate stormwater wetlands, rain gardens, or other water treatment systems with open space planning to detain additional flow and manage stormwater contaminants.
- Involve the community in ongoing weed control and enhancement planting of riparian margins.

- Upgrade and install all required inlets and outlets to appropriate inlet outlet standards including: TR2013-18 (Hydraulic Energy Management Inlet Outlet Design for Treatment devices); GD2015/004 (Water Sensitive Design for Stormwater); SWCoP 2015 (Auckland Council Stormwater Code of Practice for Land Development and Subdivision).
- Ensure fish passage is provided for where suitable.
- Incorporate water sensitive design with public capital works, and major infrastructure development.

5.1.2 Management Zone 2 – Opaheke Sports Park and Bellfield Development

The Opaheke Sportsfield concept plan has been developed to provide eight new sports fields for the Papakura/Drury communities and incorporates a groundwater bore supply, a stormwater wetland for treatment of road and carpark runoff, on-site wastewater treatment and disposal, and riparian planting. The sportsfield construction was completed in March 2015 (Fraser Thomas, 2015). The Bellfield Special Housing Area Concept plan includes engineering works to re-contour the land to control flooding issues, incorporate wetlands, and pedestrian/cycleway connections to Opaheke Sports Park. It is anticipated that a resource consent application for 300-500 homes will be lodged in 2016 (Isthmus Planning focus, 2014).

SLI_MAIN_17 (SC5) had *E.coli* concentrations that would cause a moderate risk of infection from contact such as wading. Stock access was limited along this reach and there were no local inlets that may be a source of wastewater contamination, consequently elevated *E. coli* concentrations were likely due to upstream sources of contamination.

General maintenance issues within this Management Zone:

- A potential public health concern exists at SLI_MAIN_17. *E. coli* concentrations at SC5 were above the national bottom line for contact recreation. Moderate erosion was also associated with an outlet on the TRB of this reach (UNK_018, pipe: UNK_169).
- Two outlets within the Bellfield Development area require maintenance:
    - Outlet 1115058 requires structural maintenance of the concrete wingwall.
    - Outlet 1115075 (pipe: 1133485) requires vegetation clearance and is otherwise in average condition.

Suggested goals and objectives for the Management Zones are to:

- Support watercourse enhancement opportunities identified in the draft landscape concepts including offline stormwater wetlands, increased habitat and morphological heterogeneity, and riparian planting.

- Investigate options to develop shared pedestrian/cycleway linkages along riparian corridors to connect to proposed pathways within this management zone.

5.1.3 Management Zone 3 – Croskery Drain Industrial Sector

Management Zone 3 includes the main reaches of Slippery Creek that are commonly referred to as the 'Croskery Drain'. These reaches pass through a fenced riparian corridor with a total width of 15 m, however the majority of this was dominated by *Glyceria* and other exotic weeds and shrubs. Bank stability overall was good however there was evidence of minor erosion at the toe of the graded banks which may be stabilised by providing riparian planting that is resilient to flood flows with good root penetration.

No SEV's were conducted within this zone however, SC4 was located immediately upstream of this zone in Keri Downs Park. This SEV had high sediment heavy metal concentrations that were more than double concentrations recorded in 2006. MCI score at this site were also indicative of poor water quality and received the lowest overall SEV score. The only other SEV conducted in the vicinity of the industrial sector (SC3 on Hays Stream) also had elevated sediment heavy metal concentrations that had doubled since 2006. Consequently, it is likely that this zone would also be impacted by high loadings of heavy metals.

Public access to these reaches is fairly restricted, consequently, riparian planting projects are recommended to be conducted in collaboration with local industry rather than community groups.

General maintenance issues within this Management Zone:

- Two standard outlets on SLI_MAIN_29 (ID 1115229, UNK_012) were in average condition and require erosion protection works to address moderate erosion this site, the inlet for one of these structures was also in poor condition and required debris removal (ID: 1115188, pipe: 1132816).
- Three other pipes within this zone require minor maintenance works to remove vegetation or debris on SLI_MAIN_25 (ID1133534, SLI_TRIB8_1 (ID: 1132581), and SLI_MAIN_30 (ID: UNK_175).
- Improve riparian maintenance to avoid spraying on immediate banks (particularly in the vicinity of SLI_TRIB7_2).

Suggested goals and objectives for the Management Zones are to:

- Complete riparian buffer strip to maximum width available within the designated corridor (approximately 6.5 m on each bank). Encourage local industry to 'adopt' stream reaches to further improve riparian management.
- Engage with the industrial sector to implement operational procedures and water treatment systems to manage heavy metal contaminants.

5.1.4 Management Zone 4 – Industrial Sector Southern Border – Hays Stream

Sediment concentrations of zinc exceeded the ISQG Low threshold at the SEV site located within this management zone (SC3). The concentration detected here (360 mg//kg/drywt) was nearly five times greater than the concentration recorded from a previous SEV study conducted in 2006 at the same location (Phillips *et al.* 2006). This site also maintained the highest levels of native fish diversity in all lowland SEV locations surveyed.

An opportunity exists to improve access to this stream and to engage with community and the adjacent industrial sector to enhance the riparian corridor and create a business park environment with alternative transport connectivity parallel to Hunua/Boundary Road.

General maintenance issues within this Management Zone:

- A potential public health concern exists at HAY_MAIN_12. *E. coli* concentrations at SEV site SC3 was above the national bottom line for contact recreation.
- Two outlets with no formal structure on the main channel of Hays Stream (ID: 1115574, and UNK_031) were associated with moderate, and severe erosion respectively.
- Two private culverts on HAY_TRIB2 were associated with moderate erosion, UNK_125 at the inlet point and UNK_122 at the outlet where flow was completely bypassing the culvert causing scouring under the fence.

Suggested goals and objectives for the Management Zones are to:

- Remove willows and establish a riparian corridor with a minimum width of 15 m on the TLB and 5 m on the TRB.
- Improve access to the esplanade reserve through Walker Park from Boundary Rd.
- Investigate options to develop shared pedestrian/cycleway linkages along riparian corridors to connect to proposed pathways within this management zone.
- Engage with the industrial sector to implement operational procedures and water treatment systems to manage heavy metal contaminants.

5.1.5 Management Zone 5 – Urban Open Space – Keri Downs Park, Boundary Rd Park, Greenhaven Ave/Railway St West

All streams located within public open space were identified as enhancement opportunities. The potential amenity values for watercourses in public land are high as these streams are readily accessible and provide opportunities for engaging communities to become stewards of their waterways.

Enhancement opportunities within these parks focus on improvement of riparian vegetation to provide shading to control abundant macrophytes, improve water quality, and stabilise bank erosion, as well as improving the amenity values of these parks.

SC4 located within Keri Downs park received the lowest overall SEV score. This SEV had high sediment heavy metal concentrations that were more than double concentrations recorded in 2006. The MCI score at this site were also indicative of poor water quality.

General maintenance issues within this Management Zone:

- Three easily accessible outlets on SLI_MAIN_30 immediately opposite the entrance to Keri Downs Park have unfenced drops >1.5 m that require safety improvements (ID: 1115143, 1115144,1115160), these outlets were otherwise in good condition with no maintenance requirements.
- Wastewater contamination on SLI_TRIB5_6 Asset: 1114909 (Railway St).
- Localised dense patches of aquatic pest plant parrots feather are located on SLI_MAIN_21-22 and SLI_TRIB5.
- Four outlets and 13 pipes requiring some kind of maintenance were identified within this zone:
    - Two outlets on SLI_TRIB 5 (Railway St) were in poor or very poor condition and required structural maintenance (ID:1115109, 1116832).
    - One outlet in Keri Downs Park was associated with moderate erosion (ID: 1115199 pipe: 1132835), the remnants of a concrete apron were evident however this has been undercut overtime and broken away. Two other pipes in Keri Downs Park required erosion protection works (ID: 1132779, UNK_144).
    - One outlet at the Boundary Rd park was associated with moderate erosion this outlet had no formal structure and the lip of the pipe was broken (ID: 1115547, pipe: 1133597).
- Large debris (shopping trolleys) formed jams at two locations on SLI_MAIN_31
- Investigate performance of Carrisbrook Pond and improve heavy metal management.

Suggested goals and objectives for the Management Zones are to:

- Implement Sustainable Neighbourhoods or Water Sensitive Neighbourhoods Programmes to encourage guardianship of streams in public land.
- Improve riparian maintenance works to prevent spraying of indigenous riparian vegetation.

5.1.6 Management Zone 6 – High Land Rural Lifestyle – Slippery Creek

This management zone includes the upper reaches of Slippery Creek that are disconnected from Keri Downs Park via the piped network.

Several disconnected fragments of remnant and regenerating indigenous vegetation exist within this zone many of which are currently designated significant ecological areas for a range of values including diversity, and as stepping stones and migration pathways. The resilience of these areas may be improved by engaging private landowners to improve connectivity between fragments, and reduce edge area through riparian planting.

General maintenance issues within this Management Zone:

- Potential wastewater contamination at miscellaneous private stormwater outlet on SLI_MAIN_38 (61 Kaipara Road).
- There were no inlet or outlet structures requiring maintenance within this zone.
    - One public culvert requires some debris removal (ID1134433).
    - One private culvert requires erosion protection works (UNK_140).

Suggested goals and objectives for the Management Zones are to:

- Engage with landowners to protect and enhance riparian corridors particularly in significant ecological areas.
- Contact landowners to provide education regarding management of waterways, landowner responsibilities, and supporting programmes and funding such as the Environment Initiatives Fund, or Trees for Survival.
- Take advantage of greenfield development to leverage stream enhancement outcomes (improving ecology, amenity, and stormwater functions).

5.1.7 Management Zone 7 – High Land Rural Lifestyle – Symonds and Waihoihoi

Several disconnected fragments of remnant and regenerating indigenous vegetation exist within this zone many of which are currently designated significant ecological areas for a range of values including diversity, and as stepping stones and migration pathways. The resilience of these areas may be improved by engaging private landowners to improve connectivity between fragments, and reduce edge area through riparian planting.

General maintenance issues within this Management Zone:

- One public culvert under Coal Mine Rd on SYM_TRIB2 was in poor condition and requires structural patching.

- Very high velocity discharge from farm pond UNK_117, via twin culverts (UNK_379 and UNK_380) causing severe scour of the downstream channel for a length of approximately 100 m on SYM_TRIB2_10.
- Three other private outlet points with no formal headwall or wingwall structures had moderate erosion and were undercut which may compromise structural integrity in the future (UNK_376, UNK_383, UNK_385).
- One private culvert on Symonds Stream (SYM_TRIB3) was in poor condition and required structural patching (UNK_225).

Suggested goals and objectives for the Management Zones are to:

- Engage with landowners to encourage planting of riparian corridors to reduce fragmentation of significant ecological areas as identified in Enhancement Opportunity 9.
- Contact landowners to provide education regarding management of waterways, landowner responsibilities, and supporting programmes and funding such as the Environment Initiatives Fund, or Trees for Survival.
- Take advantage of greenfield development to leverage stream enhancement outcomes (improving ecology, amenity, and stormwater functions).

5.1.8 Management Zone 8 – High Value Indigenous Forest

The upper reaches of Waihoihoi Stream are within SEA_5323 which also includes the majority of the upper reaches of Symonds Stream. This forest is characterised by mixed podocarp and broadleaf mature indigenous forest. The stream margins tended to be dominated by parataniwha, mixed tree ferns, mahoe, and nikau. The immediate watershed of the Hunua dam is dominated by mature taraire forest.

The three highest scoring SEV sites (SC1, SC9, SC10) were within this zone. All three sites scored higher than 0.83.

All reaches within this management zone are worthy of protection from land use changes, and impacts from upstream land use due to their intrinsic ecological and aesthetic values.

General maintenance issues within this Management Zone:

- There were no inlet or outlet points requiring maintenance in this zone however a private triple culvert on SYM_TRIB2 requires erosion protection works (UNK_192-194).

Suggested goals and objectives for the Management Zones are to:

- Protect high value natural streams and gullies within significant ecological areas to maintain reference conditions.

- Protect shortjaw kokopu habitat.
- Improve fish passage downstream to enable access to high quality habitat.
- Support Kauri dieback disease control programmes.
- Control feral goat and deer populations to reduce damage to watercourses and riparian vegetation within existing covenant areas.

5.1.9 Management Zone 9 – Agricultural Headwaters – Pine Plantations

Several pine plantations were situated in the headwaters of Symonds and Hays Streams, many of which were sited on the slopes of steep gullies. Several of these plantation blocks lack a riparian buffer zone with pines extending to the water's edge.

Reaches immediately downstream of pine plantations on Symonds Stream had high levels of fine silt and pine needle deposition on the floodplain from recent rain events that had occurred in the preceding weeks (see Figure 40). Some more recent plantings <5 years old also lacked riparian buffer strips such as HAY_TRIB6f (Figure 41). Conversely, a recent pine plantation had been established on HAY_TRIB6g which had also incorporated a 10 m wide planted buffer strip of indigenous shrubs and trees on each side of the channel which also formed an approximately 7 m wide riverine wetland dominated by *Carex spp.* (Figure 41).

Figure 40: Mature pine plantation at the confluence of SYM_MAIN_FORK2_TRIB7_1 and SYM_MAIN_FORK2_16 and sediment and pine needle deposition in the floodplain and channel immediately downstream on SYM_MAIN_FORK2_14



Figure 41: New pine plantations at HAY_TRIB6f (left) and HAY_TRIB6g (right).

General maintenance issues within this Management Zone:

- One public outlet under Creightons Rd (UNK_488) was associated with moderate erosion.
- One private outlet was also associated with moderate erosion (UNK_571).
- Three private culverts required some type of maintenance including:
    - UNK_016 and UNK024 on HAY_TRIB6j_8 and HAY_TRIB6g_2 respectively which both required replacement.
    - UNK_335 on HAY_TRIB6eI_2 which had minor structural damage and slight erosion at the outlet.

Suggested goals and objectives for the Management Zone are to:

- Ensure forestry activities are undertaken with best management practices with a particular emphasis on management of sedimentation including protection of vegetated buffers with a minimum width of 10 m on each side of all permanent watercourses.
- Engage with landowners to support further fencing and planting projects to protect erosion sensitive headwaters.

5.1.10 Management Zone 10 – Hunua Gorge

The true right bank of the Hunua Gorge is of high ecological value. The true left bank is influenced by edge effects from the road. Maintenance activities are limited here due to difficult access.

General maintenance issues within this Management Zone:

- Rubbish dumping, particularly on HAY_MAIN_30.

- Undercut bank lining on WAI_MAIN_29 which may present a risk to stability of Hunua Rd.
- Two outlets on the main channel of Hays Stream require maintenance:
    - One standard outlet (UNK_068) under Hunua Rd was severely undercut and at risk of structural failure, the associated bank lining was also severely undercut and requires maintenance. High sediment discharge was observed at this outlet which requires further investigation.
    - One outlet with no wingwall/apron structure under Hays Creek Rd (dam access road) was associated with severe erosion scouring a very narrow, deeply incised channel at the outlet (UNK_075).

Suggested goals and objectives for the Management Zone are to:

- Investigate options to improve fish passage at old dam infrastructure on HAY_MAIN_20.

5.1.11 Management Zone 11 – Agricultural Headwaters - Pastoral

Many of the northern reaches of this zone (north of the Hays Creek Dam including TRIB6_f-k) are fenced or otherwise restricted from stock access and consequently damage to the channels from stock was typically minor (or non-existent). The majority of HAY_TRIB6c was accessible to stock and shows signs of moderate to severe damage. These are first to second order streams which also tend to form wetland like, boggy areas at the foot of hills which may be seasonally dry; or in the western side of the Hays Creek dam, originate in springs. Intermittent streams, intermittent and permanent wetlands, and springs provide diverse, and unique habitat types that are worthy of protection for their inherent biodiversity values. Protecting headwater reaches and improving riparian buffer zones can also reduce erosion both locally in steep catchments, and downstream by aiding in stabilising banks and reducing flow velocity.

Channel modification and the formation of online ponds was also common throughout this zone resulting in altered wetland drainage, sediment export downstream, fish passage barriers, erosion at outlets, and reduced hydrological and habitat diversity. Private management of farm drainage and water storage can be a complex issue and additional support could be provided to assist landowners with the development of ecologically sensitive drainage, farm crossing, and water supply solutions.

General maintenance issues within this Management Zone:

- Two public inlet/outlet structures within this zone require maintenance
    - One standard inlet required minor patching maintenance (UNK_362) on Hunua Rd.

- One standard outlet on Hunua Rd requires replacement as the apron of the structure had detached resulting in a perched pipe (UNK_075) 1.3 m above the channel.

- Thirteen private outlets and two inlets which lacked formal headwall or wingwall structures in this zone were associated with moderate erosion including:
  - Two outlets converged at the confluence of HAY_TRIB5_5 and HAY_TRIB5b. UNK_093 (pipe:UNK_038) was situated above UNK_089 with corrugated iron placed to protect the lower culvert (pipe: UNK_099) from erosion, this was causing diversion of flow into the TRB (Figure 42).
  - A corrugated concrete culvert (UNK_092; pipe: UNK_026) under a farm crossing at HAY_TRIB5_5 was perched approximately 1.6 m above the stream resulting in a scour pool immediately at the outfall, and moderate erosion downstream. This was also associated with earthworks conducted in the stream on HAY_TRIB5_7 (Figure 42).
  - Only one outlet with moderate erosion was located on Symonds Stream, this was a perched culvert from a farm crossing over a minor unmarked tributary of SYM_MAIN_FORK2_10.
- Two private outlets from farm ponds with no associated structure had severe erosion
  - A group of six 0.15 m diameter PVC pipes formed the outlet for a headwater pond on HAY_TRIB4_3 (UNK_578, pipe UNK_018). These were perched 2.7 m above the channel.
  - A disused farm crossing damming a likely spring fed wetland on HAY_TRIB6fl_2 had been severely undercut and a 1.5 m length had fallen into the stream, the remaining pipe was perched 1.5 m above the channel. Large clumps of clay and loose fine sediment was deposited over approximately 50 m which was exacerbated by a land slip downstream adjacent to Ardmore Quarry Rd.
- Sixteen additional private culverts in this zone (not identified above) required some kind of maintenance including seven culverts in poor condition, five of these were located on HAY_TRIB6f associated with a series of six online farm ponds.
- An unmarked tributary joined on the true left of HAY_TRIB6i_5 bearing a very high sediment load resulting in high sediment deposition on the floodplain of the unmarked tributary and downstream on HAY_TRIB6i (Figure 43). The source of the sediment was undetermined but appeared to originate from Cherrington Rd.

Suggested goals and objectives for the Management Zones are to:

- Contact landowners to provide education regarding management of waterways, landowner responsibilities, and supporting programmes and funding such as the Environment Initiatives Fund, or Trees for Survival.
- Engage with landowners to encourage fencing watercourses to reduce further damage from stock access and subsequently conduct riparian revegetation particularly at first order headwaters, where riparian corridors may be connected, and wetland floodplains.
- Protect natural wetlands and springs.

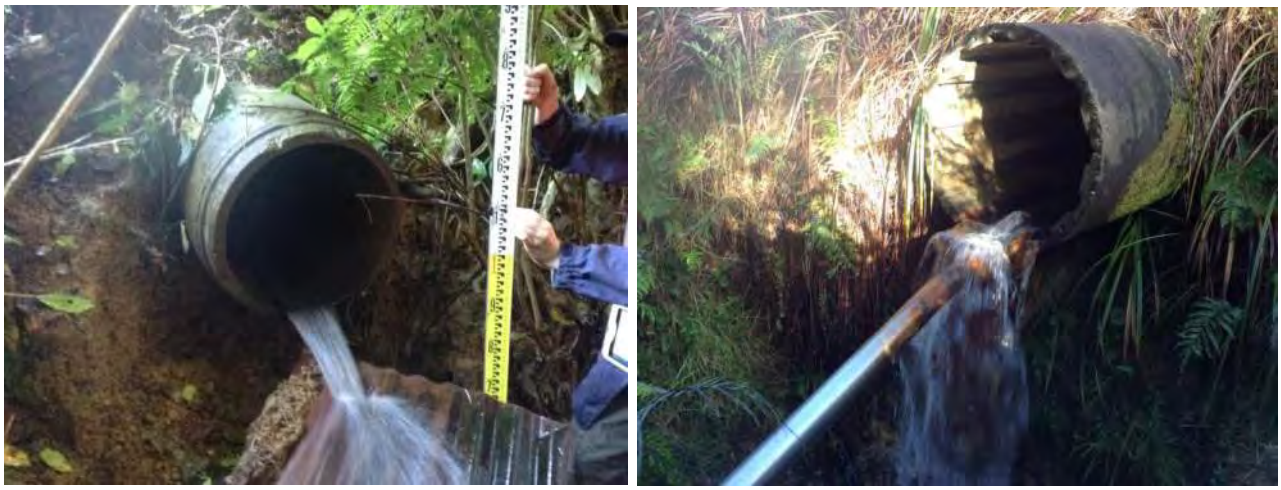


Figure 42: Upper culvert UNK_093 showing corrugated iron sheeting covering the lower culvert (right) and perched culvert UNK_092 (right) both on HAY_TRIB5_5.

Figure 43: Sediment deposition on HAY_TRIB6i_5

5.2 Enhancement Opportunities

Nine key enhancement opportunities were identified within the Slippery Creek catchment. Each enhancement opportunity is assigned a high level prioritisation based on the potential benefits to public and local amenity values, ecological values such as biodiversity and habitat improvements, and conveyance based on the general project works identified below.

Of the enhancement opportunities outlined below, only EO 1 is located entirely in public land at Keri Downs Park. However, EO 5, EO 6, and part of EO8 are located within the large future urban zoned area in the south western part of the catchment which currently is predominantly private, rural land. Although Council has limited scope to influence watercourse enhancement on private land, an opportunity may exist to protect these streams as part of structure plan development for the area.

Table 29: Summary of prioritisation of enhancement opportunities.

Enhancement Opportunity	Description	Amenity	Ecology	Conveyance	Overall Score	Prioritisation Score
EO 1	Riparian Management and Community Engagement – Keri Downs Park	High	Low	Low	8	3
EO 2	ICMP (2010) Conveyance Management Projects	Low	Mod.	High	9	2
EO 3	Riparian Corridor Connectivity – Waihoihoi Stream A	Low	High	Low	8	3
EO 4	Riparian Corridor Connectivity – Waihoihoi Stream B	Low	High	Low	8	3
EO 5	Erosion Susceptibility Mitigation Works – Symonds Stream	Mod.	Mod.	High	10	1
EO 6	Erosion Susceptibility Mitigation Works – Waihoihoi Stream	Mod.	Mod.	High	10	1
EO 7	Riparian Management and Community Engagement – Keri Hills Reserve	Mod.	Low	Low	7	4
EO 8	Riparian Management , Stormwater Asset Maintenance, and Alternative Transport Corridors	High	Mod.	Mod.	10	1
EO 9	Riparian Corridor Connectivity – Symonds Stream	Low	Mod.	Low	7	4

5.2.1 Enhancement Opportunity 1- Riparian Management– Keri Downs Park

<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td>EO-1</td><td>Area (m^2)</td><td>15,700</td><td rowspan="4">Enhancement</td><td>Community Engagement</td><td rowspan="4">Stakeholders</td><td>AC Parks</td></tr>
<tr><td>Stream</td><td colspan="3">Slippery Creek</td><td>Weed Control and Planting</td><td>Community groups</td></tr>
<tr><td>Location</td><td colspan="3">Keri Downs Park</td><td>Amenity</td><td>Residents</td></tr>
<tr><td></td><td colspan="3"></td><td>Conveyance</td><td>Local Schools</td></tr>
<tr><td>Notes</td><td colspan="8">Wai Care led community groups in a planting day in June 2009 within Keri Downs Park on both SLI_TRIB9 and SLI_MAIN_31. At the time of survey, these plantings appeared to have been severely impacted through vandalism and spray damage. Planting sites along SLI_TRIB9_1 and SLI_TRIB9_2 are monitored by the Wai Care group at Redhill School. Department of Corrections are involved in clean up and restoration work along these reaches. An integrated effort between community and Auckland Council Parks maintenance contractors is required to reinstate plantings along these reaches.

As part of the enhancement planting, access ways could be formalised on the TRB of SLIP_TRIB9. It appears that the park is a well-used access way from surrounding residential property to nearby schools. It appears that the grassed fields become muddy and slippery during winter making access through the park difficult and causing informal paths to be formed through the planting. Providing a formalised path adjacent to the reinstated planting may assist in reducing vandalism to the planting.

Dumped trolleys at SLI_MAIN_31 could also be cleared as part of a community day. Residents bordering the park could be engaged through water sensitive communities programme to encourage more consistent local guardianship of the waterways through this park particularly on Redcrest Ave, Igloo Place, Galilee Ave, Chantal Place.</td></tr>
<tr><td>Plan</td><td colspan="8"> 
</td></tr>
</table>

Photo

New riparian planting in 2009

Planting site in 2015, no plants remain

New riparian planting in 2009

Planting site in 2015, with high plant losses

Planting day in 2009 with local community members

Planting site in 2015

5.2.2 Enhancement Opportunity 2 - ICMP (2010) Conveyance Management Projects

Restoration Opportunity					Enhancement		Stakeholders	
	ID	EO-2	Area (m^2)	70,000		Conveyance		AC Stormwater
	Stream	Slippery Creek and Waihoihoi Stream				Erosion Protection		AC Parks
						Weed Control and Planting		NZTA
	Location	Slippery Creek Catchment				Amenity		Residents

Notes

The Integrated Catchment Management Plan (ICMP) for Slippery Creek (2010) identified several enhancement projects including wetland construction, installation of course sediment traps, inlet/outlet remediation, erosion protection, and fish passage improvements.

Several of these are no longer feasible due to alternative works conducted on site, however others address issues that were still present at the time of survey. These potential projects have been individually spatially recorded in the geodatabase under a collective heading as Enhancement Opportunity 2. Further details regarding each of these projects, assessed alternative solutions, and estimated budgets are provided in the 2010 ICMP.

Greenhaven Water Quality Management Project 21 (discussed as part of EO 8)

Installation of coarse sediment trap.

Croskery Road Drain/Slippery Creek Stream Erosion Control Project 67

Installation of coir fiber rolls to minimise early stage toe erosion.

Choy Block Flood Detention and SW Quality Pond Project 17

Construction of a detention dam providing flood attenuation with diversion away from existing downstream pipes towards Settlement Rd. Proposed to coincide with subdivision.

Appleby Road Drainage Improvement Project 25

Appleby and Drury Hill Roads are low and affected by surface flooding within the road and adjacent properties due to undersized culverts and lack of inlet outlet structures.

Choy Block Flood Detention and SW Quality Pond Project 18

Construction of detention pond in naturally incised gully providing flood attenuation. Proposed to coincide with subdivision.

Symonds Stream Ponga Road Crossing Fish Passage Improvement Project 55
Parker Street Online Constructed Wetland Project 22 (discussed as part of EO 8)

Expansion of existing open drain and establishment of wetland plantings.

TSO Area 2C Stormwater Management Project 16

Piping of open channel and implementing online constructed wetland with flood attenuation.

Upper Croskery Flood Detention Dams Project 16

Raising of Kaipara Road and a driveway off Papakura-Clevedon Road to form two detention Ponds

Plan	
Photo	 **Croskery Road Drain/Slippery Creek Stream Erosion Control Project 67**  **Choy Block Food Detention and SW Quality Pond Project 17**

Appleby Road Drainage Improvement Project 25. Asset ID UNK_320 450mm incorrectly labelled as 900mm on project plan. Inlet ID UNK_143. Outlet ID UNK_046

Appleby Road Drainage Improvement Project 25. Asset ID UNK_321. Inlet UNK_045. Outlet UNK_042

Appleby Road Drainage Improvement Project 25. Asset ID UNK_288. Inlet ID UNK_218. Outlet UNK_184

Appleby Road Drainage Improvement Project 25. Asset ID UNK_282. Inlet UNK_186. Outlet UNK_185

Choy Block Flood Detention and SW Quality Pond Project 18

Symonds Stream Ponga Road Crossing Fish Passage Improvement Project 55

Upper Croskery Drain Catchment Flood Detention Dams Project 15

TSP Area 2C Stormwater Management Project 16

5.2.3 Enhancement Opportunity 3 - Riparian Corridor Connectivity – Waihoihoi Stream A

<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td>EO-3</td><td>Area (m^2)</td><td>7,800</td><td rowspan="4">Enhancement</td><td>Fencing/Stock Exclusion</td><td rowspan="4">Stakeholders</td><td>Residents</td></tr>
<tr><td>Stream</td><td colspan="3">Waihoihoi Stream</td><td>Weed Control and Planting</td><td>DOC</td></tr>
<tr><td>Location</td><td colspan="3">463, 467, 473, 481 Ponga Rd and 379, 493 Drury Hills Rd</td><td>Amenity</td><td>AC – Environmental Services</td></tr>
<tr><td></td><td colspan="3"></td><td>Community Engagement</td><td>Community - Iwi</td></tr>
<tr><td>Notes</td><td colspan="8">The upper reaches on Waihoihoi Stream tributary 2 (WAI_TRIB2_20-22) are primarily open grassland with some kanuka scrub and scattered rimu and kahikatea covering a total length of approximately 230 m. An opportunity exists to complete the riparian corridor between SEA_T_4562 (downstream) and SEA_T_4563 (immediately upstream) which include mature or regenerating bush providing 70-90% cover over the stream channel. Both areas are identified as significant areas for their diversity and as a migration pathway/buffer. WAI_TRIB2_20-22 cross the boundaries of four private properties along Ponga Rd. An area further downstream on WAI_TRIB2_19 is also currently protected under covenant (ID 7149824).

Recent channel modification on WAI_TRIB2_22 has contributed to high sediment loading in the stream. There is little vegetation and stock are able to graze right up to the stream edge. There is minor damage from stock. The farm pond at WAI_TRIB2_19 had recently breached due to flood flows, an area of active recent erosion ~1.5 m high and 3.5 m wide on the true left of the pond (on the opposite side to the outlet) had resulted in high sediment deposition across the paddocks downstream and in the channel.

It is recommended that private landowners are engaged to fence off the riparian margins and subsequently replant with indigenous species and to improve farm pond management. Planting plans may be developed that would provide ecological benefits whilst also maintaining sight lines near amenity areas.</td></tr>
<tr><td>Plan</td><td colspan="8"> 
</td></tr>
<tr><td></td><td colspan="8"></td></tr>
</table>

Erosion hotspot associated with farm pond UNK_130 on WAI_TRIB2_19

Carex grasses with stock access on WAI_TRIB2_20

High sediment deposition on WAI_TRIB2_21

High bank erosion and sedimentation on WAI_TRIB2_22

Pond downstream of WAI_TRIB2_22

WAI_TRIB2_19 Kanuka Bush within SEA_T_4562

WAI_TRIB2_23 within SEA_T_4563

5.2.4 Enhancement Opportunity 4 - Riparian Corridor Connectivity – Waihoihoi Stream B

<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td>EO-4</td><td>Area (m^2)</td><td>11,000</td><td rowspan="4">Enhancement</td><td>Weed Control and Planting</td><td rowspan="4">Stakeholders</td><td>Residents</td></tr>
<tr><td>Stream</td><td colspan="3">Waihoihoi Stream</td><td>Amenity</td><td>DOC</td></tr>
<tr><td></td><td colspan="3"></td><td>Community Engagement</td><td>AC – Environmental Services</td></tr>
<tr><td>Location</td><td colspan="3">383, 491 Drury Hills Rd</td><td></td><td>Community - Iwi</td></tr>
<tr><td>Notes</td><td colspan="8">Upstream of Waihoihoi Stream tributary 7 (WAI_TRIB2_7) is SEA_T_1173 which is identified as significant due to its diversity. To the south of this is a small pocket of vegetation that is identified for its threat status and rarity (SEA_T_1174).

The Auckland Council GIS catchments and hydrology layer identifies the stream to extend through SEA_T_1173 and up towards SEA_T_1172 which was designated an SEA for its representatives and threat status and rarity. An opportunity exists to fence and plant an open, pastoral length of stream (175 m between the two larger SEAs to complete the riparian corridor and reduce fragmentation.

To the North of SEA_T_1173 is a heritage site of value to Mana Whenua. The ID number for this is 1195.</td></tr>
<tr><td>Plan</td><td colspan="8">  </td></tr>
<tr><td>Photo</td><td colspan="8"> 
WAI_TRIB7_7 looking upstream</td></tr>
</table>

5.2.5 Enhancement Opportunity 5 - Erosion Susceptibility Mitigation Works – Symonds Stream

Restoration Opportunity					Enhancement		Stakeholders	
	ID	EO-5	Area (m^2)	246,600		Erosion Protection		AC Stormwater
	Stream	Waihoihoi and Symonds Stream				Conveyance		AC – Environmental Services
	Location	109, 117, 125 174-190, 198, 220, 238 Ponga Road. 240, 233 Sutton Road. 35-41 Jack Paterson Road.				Fencing/Stock Exclusion		Residents
						Fish Barrier		

Notes

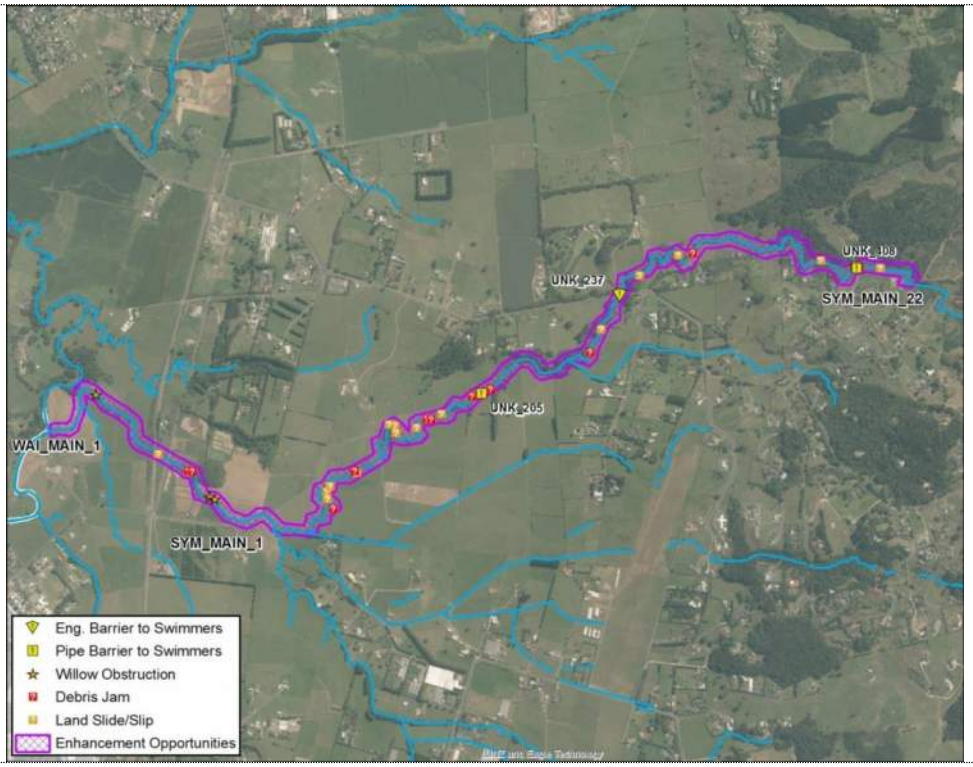
A section of the Waihoihoi Stream and Symonds stream has high bank erosion, low bank stability and numerous instances of willows altering stream hydrology. The section of stream that has been affected includes the lower reaches of the Waihoihoi stream (WAI_MAIN_1-8) and the lower reaches of Symonds Stream (SYM_MAIN_1-22) with a total length of approximately 3 km.

Willows located in stream or with limbs crossing the stream bed are a common occurrence throughout the area; in some cases the willows are exacerbating erosion issues and affecting the morphology of the stream and forming barriers to fish passage. Two other key barriers to fish passage including one public outlet (UNK_237), and one private culvert (UNK_205), may also be addressed in conjunction with other works.

The banks along this reach are characterised by sheer gradients with the common vegetation development type being grasses with limited overhead cover. This is likely to be the main issue that is contributing to the high concentration of erosion hotspots and slumping along this section of stream. Remedial works are required to prevent further erosion and slumping of the stream banks as well as any subsequent sediment deposition.

A cost effective remediation option could be to regrade the banks to a more stable gradient such as a 1:1 batter. Erosion protection such as rock could be installed at the toe of the banks. It is also recommended that the sections of stream that are easily accessible to stock are adequately fenced off to prevent access. This will ensure that degradation of the stream banks through repeated stock exposure does not occur. Following bank regrading, planting a riparian buffer would further improve bank stability and provide additional ecological benefits such as shading, filtration, and habitat provision. Due to the current channel morphology (sheer banks averaging 1.8-2 m high) riparian planting in isolation is unlikely to sufficiently stabilse the banks. A 40 m riparian corridor with a minimum of 10 m on each bank is recommended.

Further investigations are required to assess the options available and their associated costs to ensure the most appropriate solutions are implemented. It may be possible to develop a riparian park in association with future structure plan changes to provide an urban respite and alternative transport corridors to key public amenities and infrastructure such as the Opaheke Sports Park and Papakura Train Station.

Plan	 UNK_237 UNK_205 SYM_MAIN_22 WAI_MAIN_1 SYM_MAIN_1 Eng. Barrier to Swimmers Pipe Barrier to Swimmers Willow Obstruction Debris Jam Land Slide/Slip Enhancement Opportunities

Photo

Willow in Stream bed altering hydrology on WAI_MAIN_1

Willow in stream causing altered hydrology and partial barrier to swimmers on WAI_MAIN_6

Cascade over Willow roots. Scoured pool immediately downstream with bank slip at SYM_MAIN_5

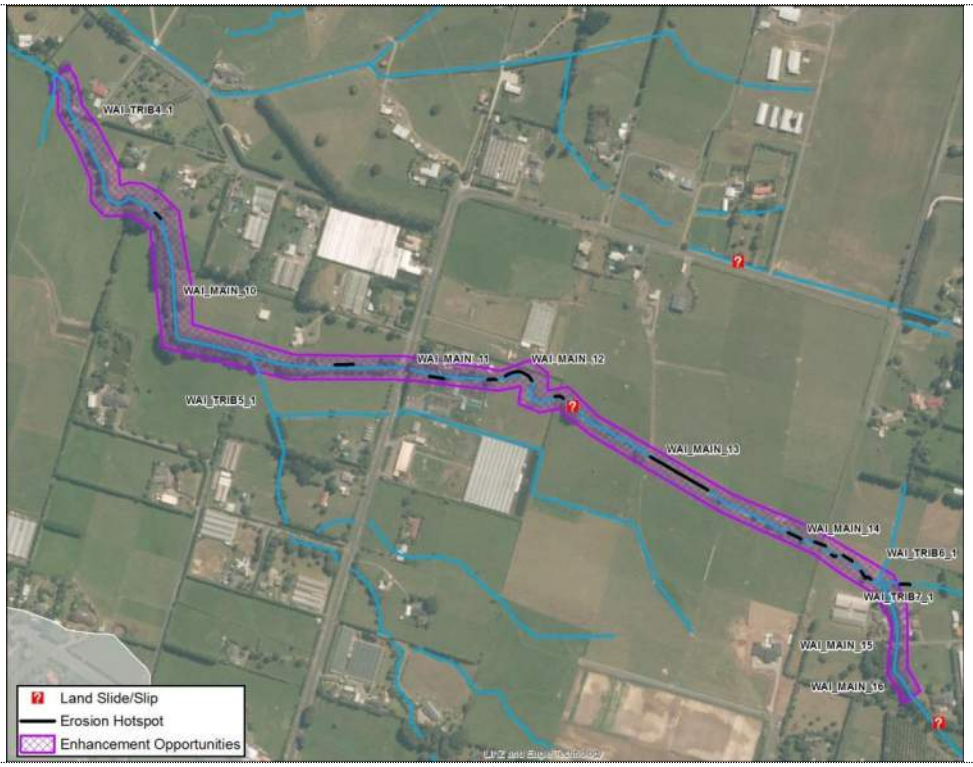
Landslip at SYM_MAIN_5

Large Willow in stream causing debris jam and obstructing flood conveyance on WAI_MAIN_9

50 m^2 erosion hotspot on SYM_MAIN_20

5.2.6 Enhancement Opportunity 6 - Erosion Susceptibility Mitigation Works – Waihoihoi Stream

Restoration Opportunity	ID	EO-6	Area (m^2)	56,400	**Enhancement**	Erosion Protection	**Stakeholders**	AC Stormwater
	Stream	Waihoihoi Stream				Conveyance		AC – Environmental Services
	Location	56, 60, 64, 100 Harry Dodd Road. 103, 128, 253 Appleby Road. 373-303 Cossey Road. 400, 410, 414 Drury Hills Road				Fencing/Stock Exclusion		Residents
Notes	A section of the Waihoihoi Stream has become degraded with high bank erosion and slumping, as well as, poor upper bank stability. The section of stream extends 1.6 km through WAI_MAIN_10 to WAI_MAIN_15. Thirteen erosion hotspots, collectively 300 m in length have been identified along 1.6 km section. Other issues within the reach include debris jams and a high percentage of banks with erosion >40% (either 40-60% or >60% on ecolines). Local residents have attempted to mitigate the active erosion. The landowner at WAI_MAIN_10 has requested channel straightening and indicated that the true right bank has eroded back more than 3 m. Another bank on WAI_MAIN_12 has been recently widened and regraded in an attempt to mitigate erosion. The banks along this reach are characterised by steep gradients with little to no vegetation other than grass. It also appears that sections of the stream have been straightened in the past and that some of the erosion has been caused by the streams propensity to meander. These are likely to be the main issues that are contributing to the high concentration of erosion hotspots and slumping along this section of stream. Remedial works are required to prevent further erosion and slumping of the stream banks as well as any subsequent sediment deposition. A cost effective remediation option could be to regrade the banks to a more stable gradient such as a 1:1 batter, similar to works conducted on WAI_MAIN_12. Erosion protection such as rock could be installed at the toe of the banks. Naturalisation of the stream to incorporate meanders could also help mitigate against erosion. Following bank regrading, planting a riparian buffer would further improve bank stability and provide additional ecological benefits such as shading, filtration, and habitat provision. A 40 m riparian corridor with a minimum of 10 m on each bank is recommended. It is also recommended that the sections of stream that are easily accessible to stock are adequately fenced off to prevent access. This will ensure that degradation of the stream banks through repeated stock exposure does not occur. Sections where erosion is more severe and where there is higher risk to dwellings may require retaining structures. Further investigations are required to assess the options available and their associated costs to ensure the most appropriate solutions are implemented.							

Plan	 WAI_TRIB4_1 WAI_MAIN_10 WAI_MAIN_11 WAI_MAIN_12 WAI_TRIB5_1 WAI_MAIN_13 WAI_MAIN_14 WAI_TRIB6_1 WAI_TRIB7_1 WAI_MAIN_15 WAI_MAIN_16 Land Slide/Slip Erosion Hotspot Enhancement Opportunities

Photo

Erosion hotspot on true right bank on WAI_MAIN_10

Erosion hotspot approximately 80 m2 on true right bank on WAI_MAIN_12

Undercut bank on true left bank on WAI_MAIN_14

Erosion hotspot on true left bank

The true right bank on WAI_MAIN_12 has been widened and regraded. Pasture grasses on both banks.

5.2.7 Enhancement Opportunity 7 - Riparian Management and Community Engagement – Keri Hills Reserve

Restoration Opportunity	ID	EO-7	Area (m^2)	9,500	**Enhancement**	Community Engagement	**Stakeholders**	AC Parks
	Stream	Slippery Creek				Weed Control and Planting		AC Stormwater
						Amenity		Residents
	Location	Kaipara Hills Reserve						
Notes	Two reaches on Slippery Creek (SLI_TRIB12_3-4) pass through Keri Vista Detention Pond Reserve and Kaipara Hills Reserve which are both zoned as 'Public Open Space – Informal Recreation'. SLI_TRIB12_3 is located to the north east of the Keri Vista detention pond. Both banks have been planted (<5 years) with native species as part of the detention pond planting. Gorse has established throughout the planting. The reach is lined with gabion baskets along both banks. SLI_TRIB12_4 flows through the southern boundary of Kaipara Hills Reserve and is overgrown with blackberry and Japanese honeysuckle. Kaipara Hills Reserve crosses over Slippery Creek and links Kaipara Road to Keri Vista Rise. In conjunction with weed control and riparian planting, a cycleway/walkway through Kaipara Hills Reserve would provide valuable pedestrian linkages as well as an enhanced green space for the community. The cycleway/walkway would provide key linkages for residents on Kaipara Road to Keir Vista Rise, small neighbourhood reserves around Keri Vista Rise and the main centre of Papakura. The restoration project would provide an opportunity to engage local community members on both banks of Slippery Creek.							
Plan								

Photo

SLI_TRIB12_3

SLI_TRIB12_4

Keri Vista detention Pond

5.2.8 Enhancement Opportunity 8 - Riparian Management, Stormwater Asset Maintenance, and Alternative Transport Corridors

<table>
<tr><td rowspan="4">Restoration Opportunity</td><td>ID</td><td colspan="2">EO-8</td><td>Area (m^2)</td><td>176,100</td><td rowspan="4">Enhancement</td><td>Weed Control and Planting</td><td rowspan="4">Stakeholders</td><td>AC - Parks</td></tr>
<tr><td>Stream</td><td colspan="4">Slippery Creek and Hays Stream</td><td>Outfall Erosion</td><td>Auckland Transport</td></tr>
<tr><td>Location</td><td colspan="4">37 Hunua Road, Walker Park, Opaheke Sports Park, Opaheke Road</td><td>Amenity</td><td>Residents</td></tr>
<tr><td></td><td></td><td colspan="4"></td><td>Naturalising</td><td>NZTA</td></tr>
<tr><td>Notes</td><td colspan="9">The area that constitutes this enhancement opportunity includes SLI_MAIN_18-22, SLI_TRIB5, SLI_MAIN6 and between HAY_MAIN_1 and HAY_MAIN_15.

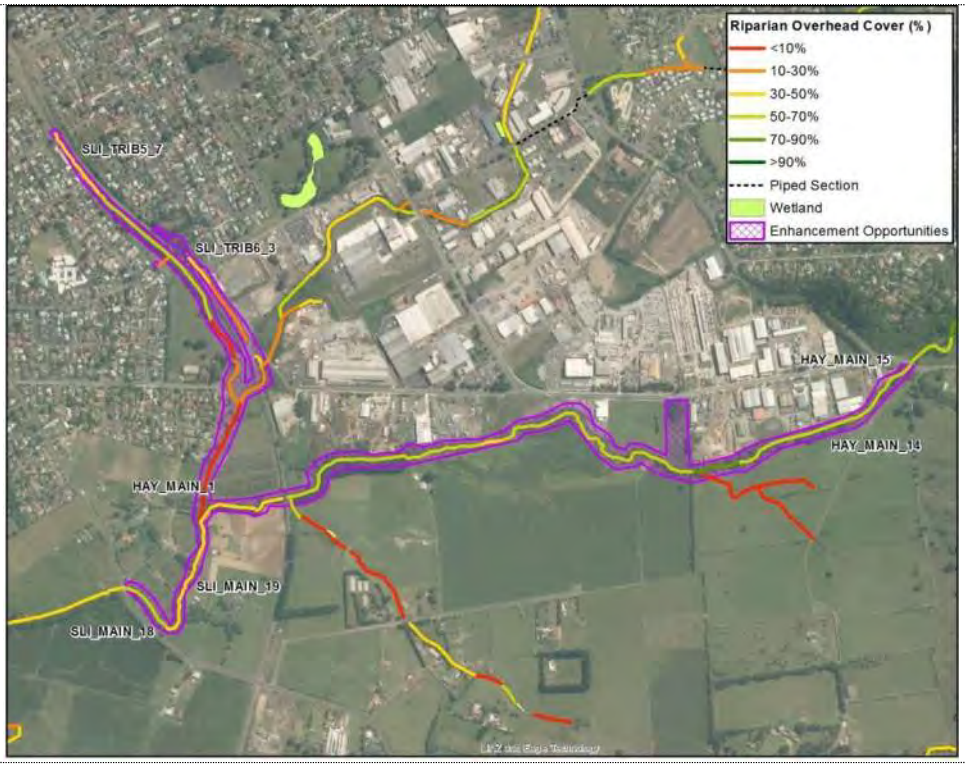
The reaches upstream of Opaheke Sports Park have been identified as an enhancement opportunity to increase connectivity of public spaces, provide riparian planting initiatives and erosion control, willow removal projects, and general maintenance concerns. This enhancement opportunity also forms part of the proposed cycleway and pathway that was identified in this Watercourse Assessment. Ngati Tamaoho have proposed that Hays Creek is renamed ‘Waipokapu’ which may be translated as ‘the water shortcut or direct route’. This may be an appropriate name for the proposed pathway, however further consultation with relevant stakeholders would be required.

The issues of concern within SLI_MAIN_18-22 include a public asset with moderate erosion and general bank erosion. It is recommended that the public asset is fitted for erosion protection and undergoes structural repair (Asset ID 1115547). Re-contouring and regrading of the banks within the reach will help to restore stability and planting will increase the resistance of the banks against further erosion. There is some evidence of recent planting along SLI_MAIN_21 and it is recommended that this be continued and enhanced through the internal recreation area to improve bank stability and provide a riparian corridor to areas upstream.

Slippery Creek tributaries 5 and 6 have been identified for weed control, riparian planting and stormwater structure maintenance requirements. It is recommended that riparian planting of 5 m on the true right bank within the informal recreational area be undertaken in collaboration with local residents and community. The planting should consist of low growing plants to maintain sight lines for public safety. The planting should be implemented in conjunction with some re-contouring of the stream channel to help mitigate bank erosion.

The area of enhancement on these tributaries coincides with projects from the Slippery Creek ICMP (2010) that identifies the need for two coarse sediments traps (located upstream of SLI_TRIB5a_1 and SLI_TRIB5_7) and a wetland upstream of SLI_TRIB6_3.

The lower reaches of Hays Stream (HAY_MAIN_1-15) have been identified to further increase the connection to Opaheke Sports Park and provide amenity, highlight maintenance issues and provide an access way to Walker Park. Maintenance requirements include willow removal on HAY_MAIN_10, HAY_MAIN_12, HAY_MAIN_13 and rubbish dumping behind industrial properties at HAY_MAIN_14. It is recommended that the riparian planting be undertaken with a buffer of 15 m on the true left bank. The proposed cycle way will run alongside this with a width of 3 m. It is recommended that an access way is developed between Walker Park (Boundary Rd) and the esplanade strip.</td></tr>
</table>

Plan	
Photo	 **Willow instream on WAI_MAIN_12**

Rubbish dumping on HAY_MAIN_12

SLI_TRIB5_2 assessed April 2015

SLI_TRIB5_2 viewed August 2015.

Erosion protection and structural repair required at outlet Asset ID 1115547

SLI_TRIB5_6 (5 m riparian margin TRB, enhancement on TLB), SLI_TRIB5_7 (low growing veg only for sight lines).

Sewage fungus at Asset 1135579. Poor condition structure separated from pipe (Asset ID 1116832)

SLI_TRIB5a_1 install course sediment trap (Asset ID 1115109). Greenhaven Water Quality Management ICMP Project 21

Parker Street proposed wetland upstream of SLI_TRIB6_2. ICMP Project 22

5.2.9 Enhancement Opportunity 9 - Riparian Corridor Connectivity – Symonds Stream

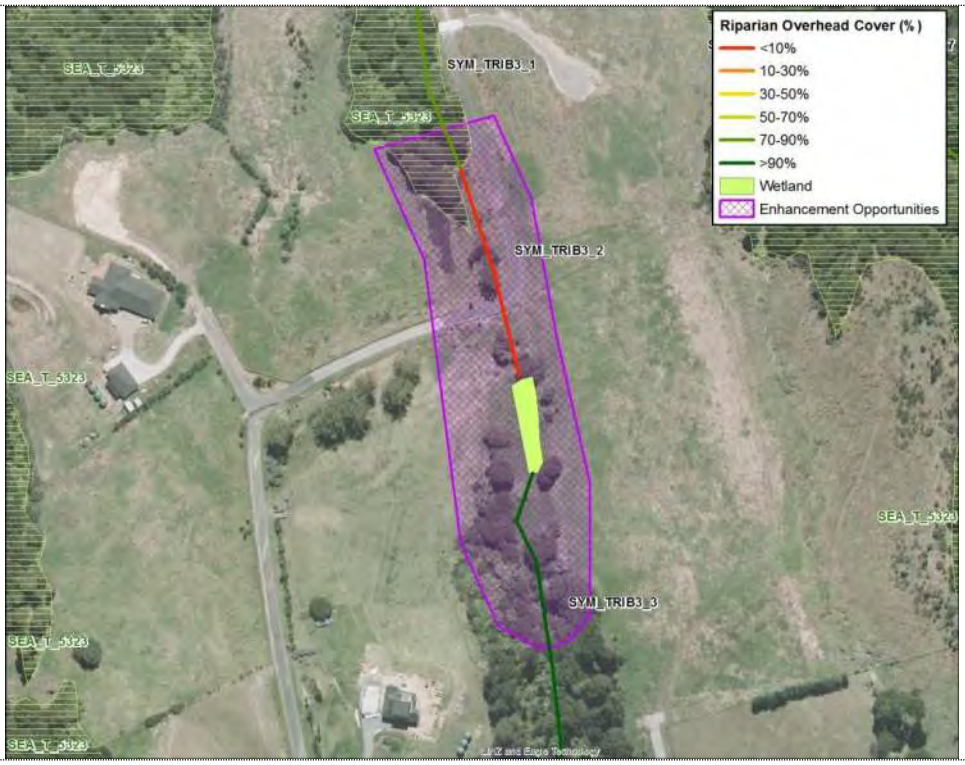
Restoration Opportunity	ID	EO-9	Area (m^2)	12,100	**Enhancement**	Weed Control and Planting	**Stakeholders**	Residents
	Stream	Symonds Stream				Community Engagement		DoC
	Location	80, 144 Judge Richardson Drive						AC - Environment
Notes	Tributary 3 of Symonds Stream (SYM_TRIB3_2&3) is located within a subdivision with new dwellings and life-style blocks under development. An opportunity exists to engage with neighbours and community through planting and weeding initiatives. Through development, the continuous forest connection from SYM_TRIB3 to the main stem of Symonds Stream (SYM_MAIN_26) has been fragmented. The bush surrounding SYM_MAIN_26 is designated significant ecological area (SEA_T_5323) and consists of regenerating native vegetation. Vegetation along tributary 3 of Symonds Stream also consists of regenerating native vegetation, however is impacted by edge effects where a driveway intersects the riparian corridor. Approximately 150 m between the two areas of regenerating forest is dominated by pasture grasses and exotic weeds including *Tradescantia*, ginger, arum lily, impatience and Himalayan honey suckle. Weed control is recommended to control invasive weed infestations before they spread into the SEA. Planting native vegetation 20 m either side of tributary 3 over the 150 m long reach is recommended to complete the riparian corridor. This would provide connectivity, reduce the edge effects, limit weed establishment and improve the ecological integrity of the riparian corridor.							
Plan								

Photo	 **Regenerating native bush on Symonds Stream SYM_MAIN_26**  **Regenerating native bush upstream of the enhancement opportunity SYM_TRIB3_3**  **Edge effects evident upstream of driveway crossing over Tributary 3 of Symonds Stream**

5.3 Auckland Council Maintenance Contract

Intergroup is responsible for implementing the 'Southern area stormwater maintenance contract' for Auckland Council. This contract includes the Slippery Creek catchment area. The Contract Works to be carried out under this contract include, but are not limited to, the regular maintenance of the Auckland Council's stormwater assets and Auckland Transport stormwater assets in the southern Area. This includes maintenance of pipeline, open channel, watercourses, culverts, ponds, treatment devices, catch pits and soak holes within the urban areas.

The contract includes regular inspections for both lined and unlined channels specifically identified within the contract.

Options for maintenance outlined within this Watercourse Assessment Report (WAR) may be addressed under the Maintenance Contract where appropriate. A summary of engineering maintenance works is provided in Appendix C.

Other maintenance contracts administered by Auckland Council, such as contracts for the maintenance of parks and open spaces and/or the maintenance of environmental reserves, may also be important to consider in relation to the management of watercourses within the Slippery Creek catchment. However, these contracts were not supplied and, therefore, cannot be assessed under this section of the report.

6.0 Conclusions

The Slippery Creek catchment covers 46.3 km^2 and is predominantly rural with the origins of the streams located in the Hunua foothills which are largely undisturbed with remnant or regenerating indigenous forest. This area encompasses the legacy catchments of Croskery Rd Drain, Bellfield, Hays Stream, and the Symonds and Waihoihoi Stream catchments.

Rural Papakura can be divided into two key characteristic areas; the flat, drained lands of the Manukau Ecological District, and the steep hill country in the western foothills of the Hunua Ecological District. These two ecological areas are delimited by the Drury fault line which runs from north to south.

The majority of stream reaches in the Slippery Creek catchment were soft bottomed streams dominated by silt/sand substrates. Nearly 50% of reaches assessed had >50% of their area covered by fine sediment deposition. The impacts of this were particularly apparent in some high land soft bottomed streams with up to a 1 m depth of loose unconsolidated sediment accumulated in slower moving reaches.

Approximately 25% of channels assessed had some degree of modification. The majority of modified reaches were observed through industrial and residential areas of Slippery Creek for increased conveyance and bank stability, and modified channels increasing farm drainage in agricultural areas.

Incidental fish observations were rare during the course of this field survey and almost all SEV sites where electrofishing had been undertaken resulted in poorer fish IBI scores than previous assessments. This may be partly attributable to the prevalence of fish passage barriers in the catchment such as a decommissioned dam structure which formed a near vertical concrete wall ~5 m high on HAY_MAIN_20

A cluster of fish passage improvements has been recommended on the lower reaches of Waihoihoi and Symonds Streams. Removal of five partial barriers formed by willow roots and three other culvert structures would improve access to the high ecological value reaches of the upper forks of Waihoihoi and Symonds Streams (approximately 20 km of potential habitat). The lower reaches of Slippery Creek could also be targeted for further investigation of improvements to inanga spawning habitat. Wide, accessible floodplains in the lower reaches are currently dominated by *Glyceria sp.* which is not a preferred vegetation type for inanga spawning, and accessible to stock.

Bank stability and erosion is a significant issue for Slippery Creek with over 30 erosion hotspots identified covering a total area of approximately 1,160 m^2. The majority of these are clustered on Symonds and Waihoihoi Streams, west of the Drury fault line. Erosion mitigation works have been recommended to address these issues.

Agricultural practices can have a range of adverse impacts on stream ecological health, conveyance, and water supply. Particular issues encountered in Slippery Creek included poorly maintained farm crossings and pond outlets, lack of buffer plantings within pine plantations, earthworks conducted in a watercourse without appropriate sediment control, and damage to riparian margins and channel morphology due to stock access. These issues were fairly common within the Slippery Creek catchment.

Collectively, riparian vegetation intactness, habitat diversity, and bank erosion were the three primary limiting variables of stream ecological health.

The Slippery Creek sub-catchment is predicted to be the greatest contributor of sediments to the Pahurehure Inlet and one of the second greatest contributors of heavy metal contaminants (Green, 2008). Reducing erosion and sediment discharge is therefore a key priority for the Slippery Creek catchment. Many of the key goals and objectives identified below aim to reduce erosion and contaminant issues in addition to other ecological, community, and conveyance outcomes.

Key goals and objectives for the catchments identified across the eleven management zones include:

- Establish 40 m wide riparian corridors with a minimum width of 10 m on each bank on the main channels of Symonds Stream and Waihoihoi Stream, and tributary 5 of Waihoihoi Stream.
- Future proof channels through erosion protection works.
- Upgrade and install all required inlets and outlets to appropriate inlet outlet standards including: TR2013-18 (Hydraulic Energy Management Inlet Outlet Design for Treatment devices); GD2015/004 (Water Sensitive Design for Stormwater); SWCoP 2015 (Auckland Council Stormwater Code of Practice for Land Development and Subdivision).
- Incorporate shared cycle/walkways along riparian corridors to improve connectivity to key recreational and transport infrastructure such as the Opaheke Sports Park and the Papakura Park and Ride.
- Manage willows to reduce erosion from flow diversion, debris jams, and improve fish passage to upstream high value habitat.
- Engage landowners to fence watercourses where moderate to severe stock damage has occurred to reduce further damage and ongoing sediment and faecal pollution downstream.
- Implement Sustainable Neighbourhoods or Water Sensitive Neighbourhoods Programmes to encourage guardianship of streams in public land.
- Provide education regarding management of waterways, landowner responsibilities, and supporting programmes and funding such as the Environment Initiatives Fund, or Trees for Survival.

- Ensure forestry activities are undertaken with best management practices with a particular emphasis on management of sedimentation.
- Improve resilience of remnant and regenerating indigenous forest by restoring connections between nearby fragments particularly along riparian corridors.
- Protect natural headwater and floodplain wetlands and springs.

7.0 References

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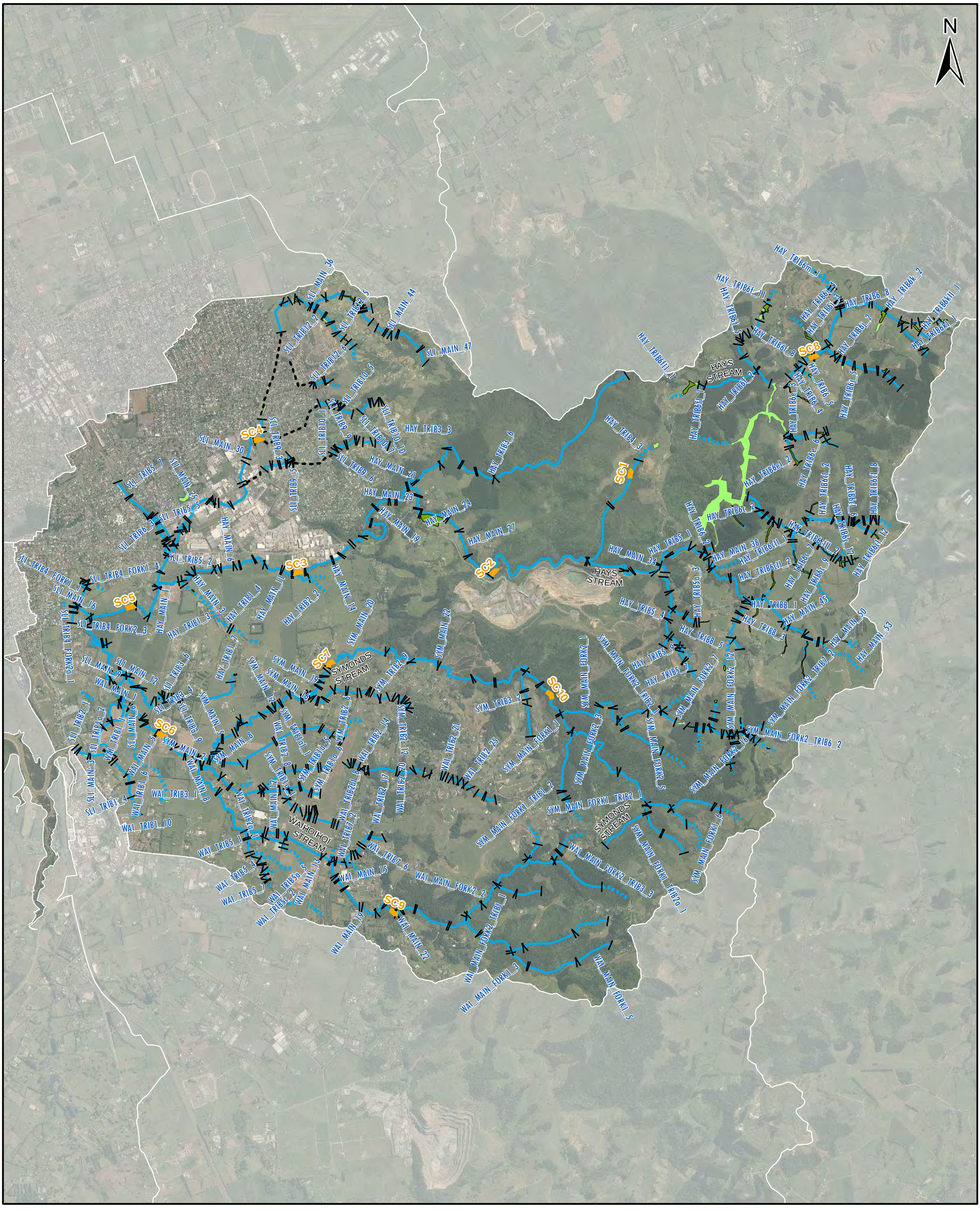
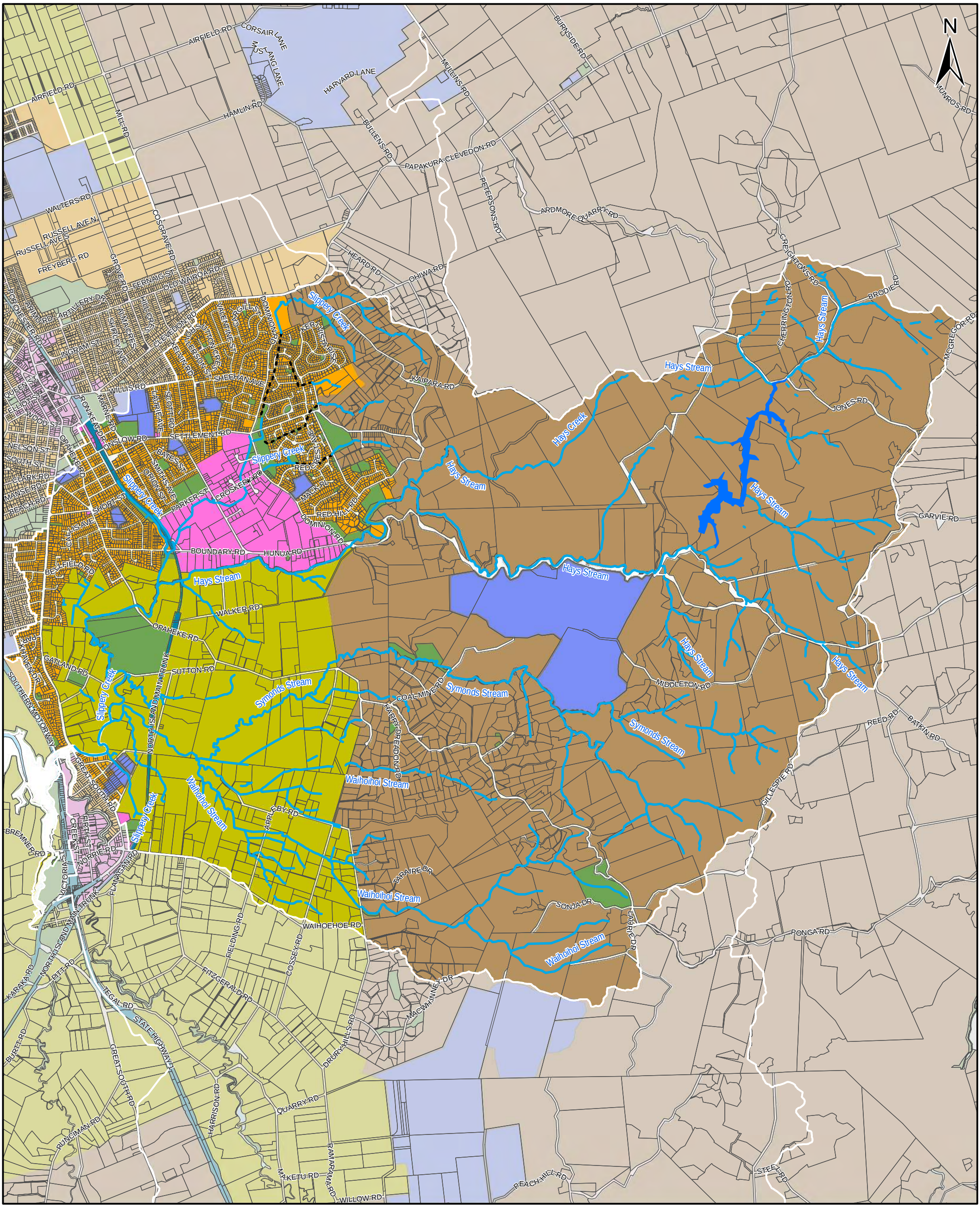
Appendix A Maps

Map 1: Overview Map



Map 2: Catchment Landuse



PAUP Base Zone

- Business
- Open Space
- Special Purpose
- Rural
- Residential
- General
- New Growth
- Stormwater Catchments
- Eco Line
- Piped Section

0 700 1,400

m

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Project: Slippery Creek WAR	
Project No: P00314	
Client: Auckland Council	
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Sheet 2 of 8	Version: 1
Date: 12/01/16	Drawn by: CU
Map Number:	Approved by: ML

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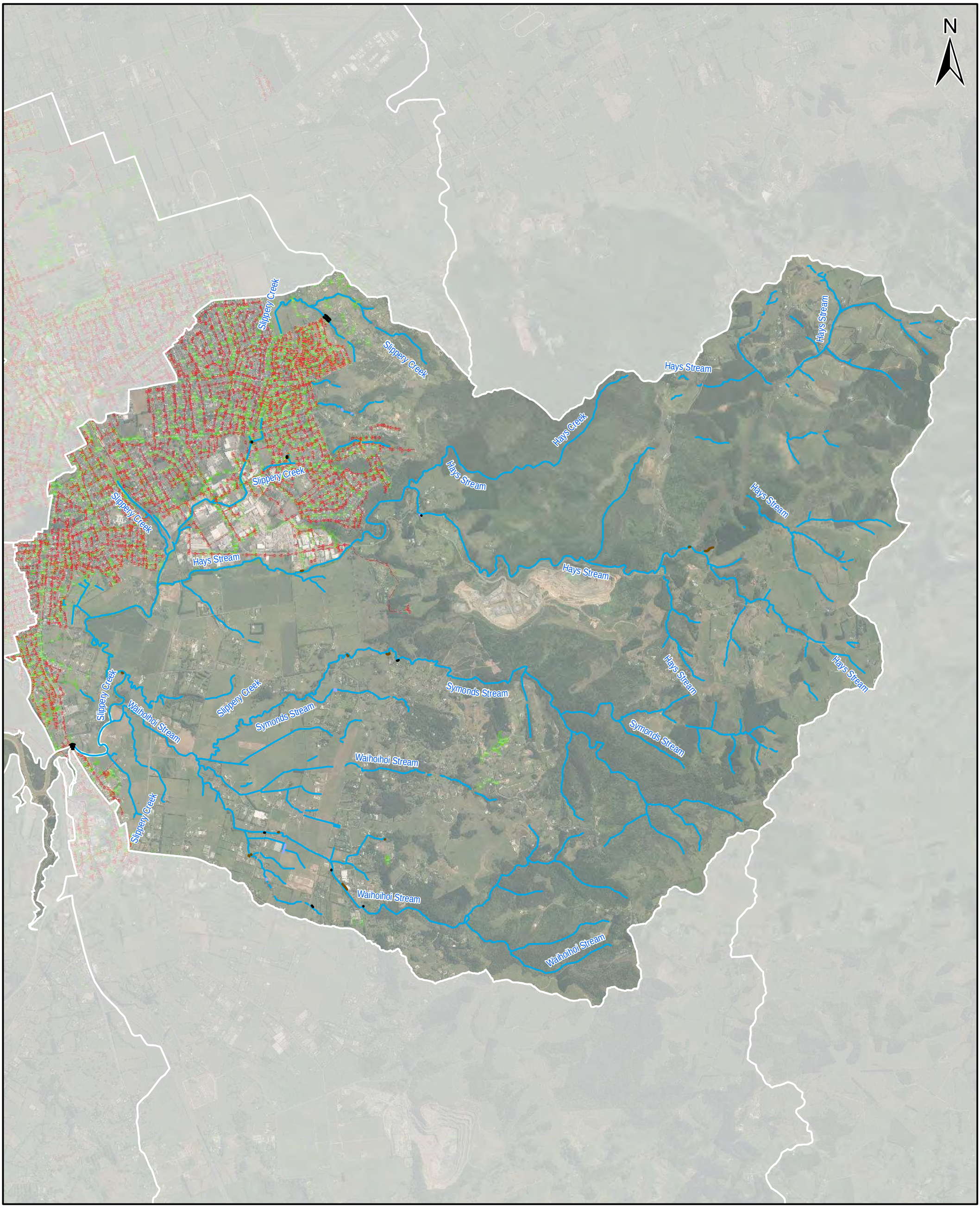
Map 3: Bank and Channel Modification Type & Extent



Bank and Channel Lining
- Cast In Situ Concrete
- Galvanised iron or steel
- Gabion Basket
- Masonry Block
- No material
- Other
- Reno mattress channel
- Rock
- Timber
- Ceramic/Earthenware
- Stormwater Catchments

Stormwater Fitting
- Catchpit
- Inlet or outlet
- Manhole
- Quality/Treatment device
- Stormwater Drain
- Wastewater Manhole
- Wastewater Pipe
- Eco Line

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Project No: P00314	
Client: Auckland Council	
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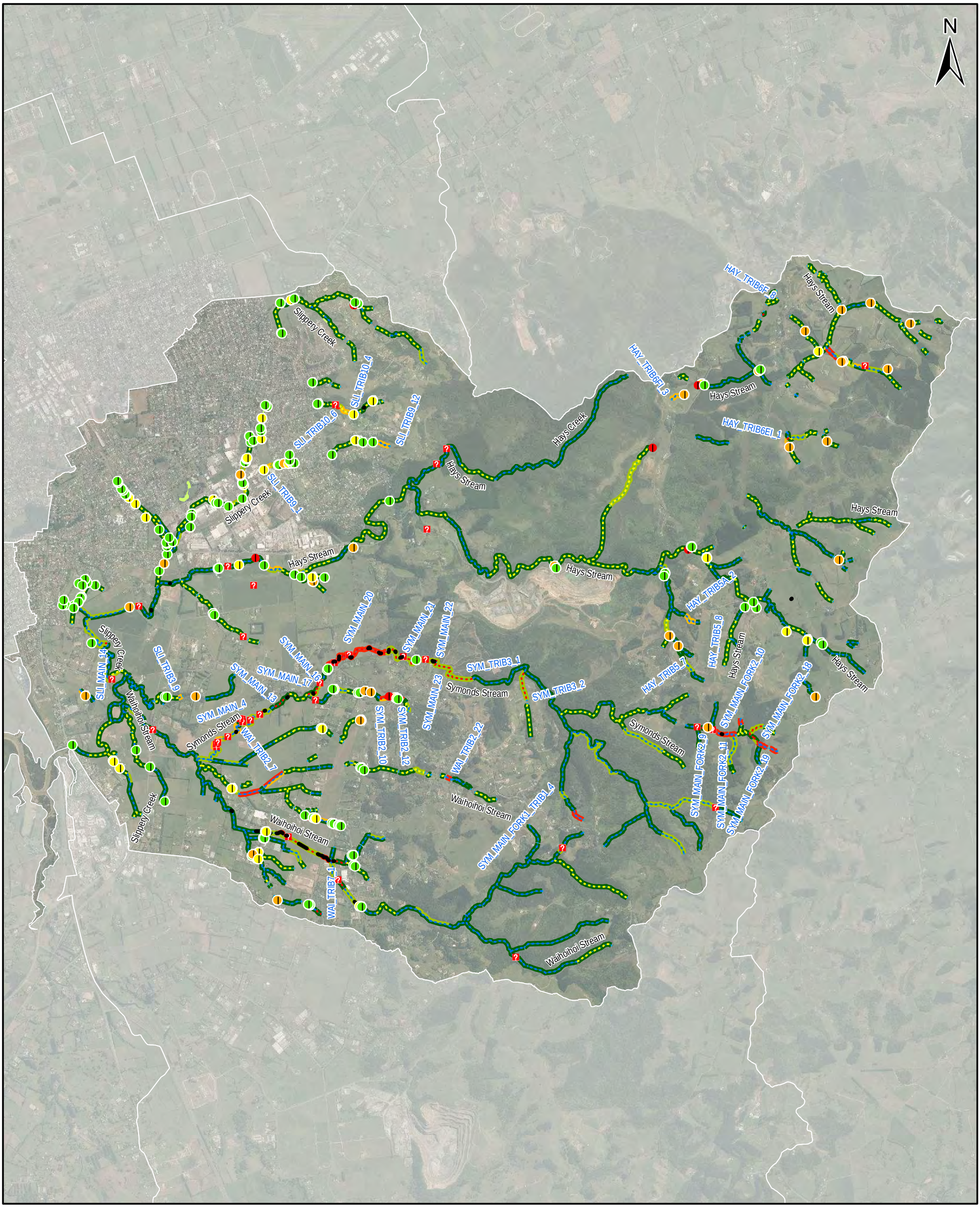
Map 4: Engineering Asset Locations, Stream Bank & Outfall Erosion



Erosion Scars
- <20%
- 20-40%
- 40-60%
- >60%

Inlet/Outlet Erosion
- None
- Slight
- Moderate
- Severe
- Could not locate

Bank Stability
- Excellent
- Fair
- Good
- Poor
- Erosion Hotspot

- Stormwater Catchments
- Stormwater Wetland/Pond

Miscellaneous
- Land Slide/Slip

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m

Project: Slippery Creek WAR	
Project No: P00314	
Client: Auckland Council	
Scale: 1:35,000@ A3	
Sheet 4 of 7	Version: 1
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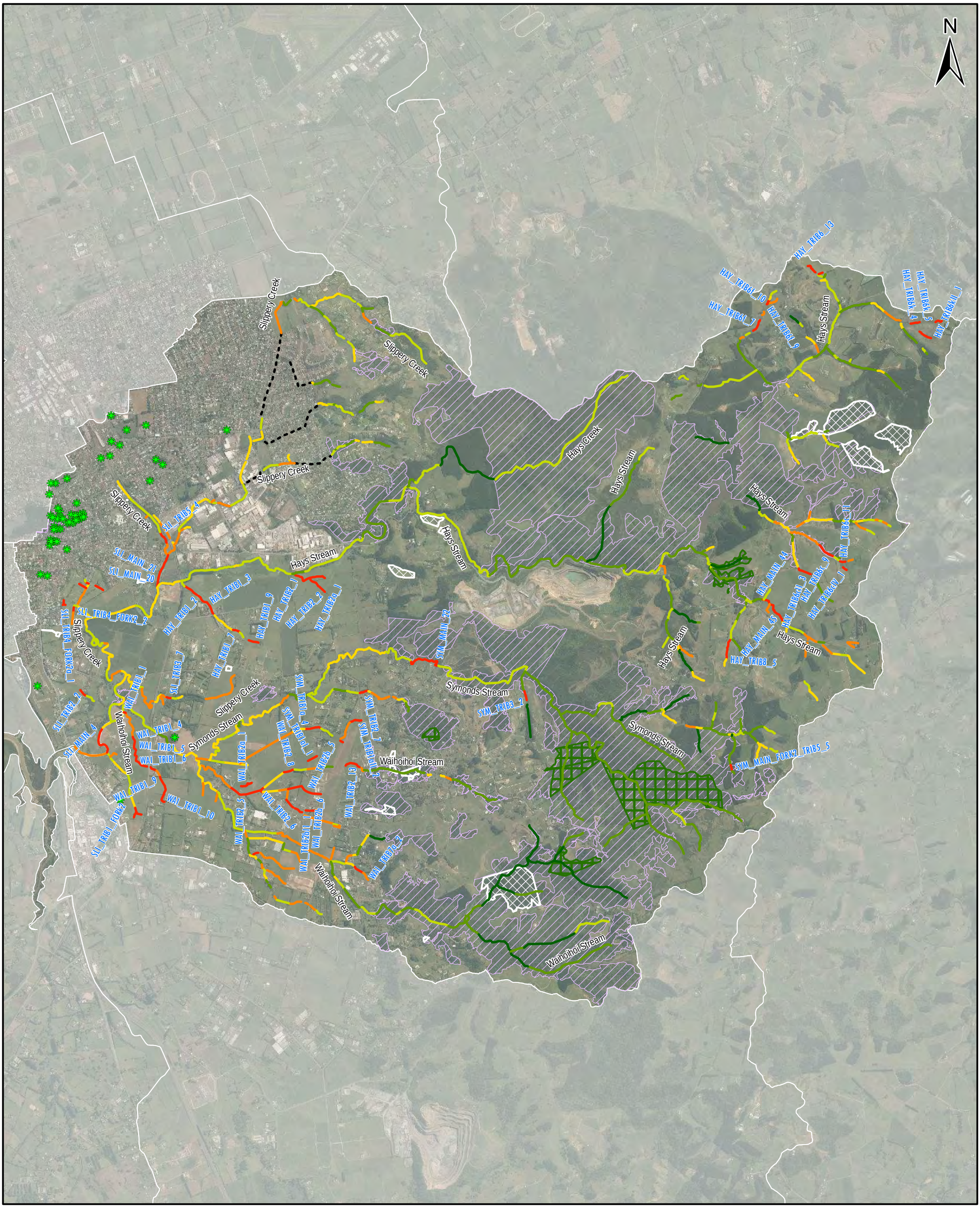
Map 5: Riparian Overhead Cover



Overhead Shading
- <10%
- 10-30%
- 30-50%
- 50-70%
- 70-90%
- >90%

- Stormwater Catchments
- Piped Section
- Prot. Areas QEII Covenants
- Significant Ecological Areas
- Notable Trees
- Covenants

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m

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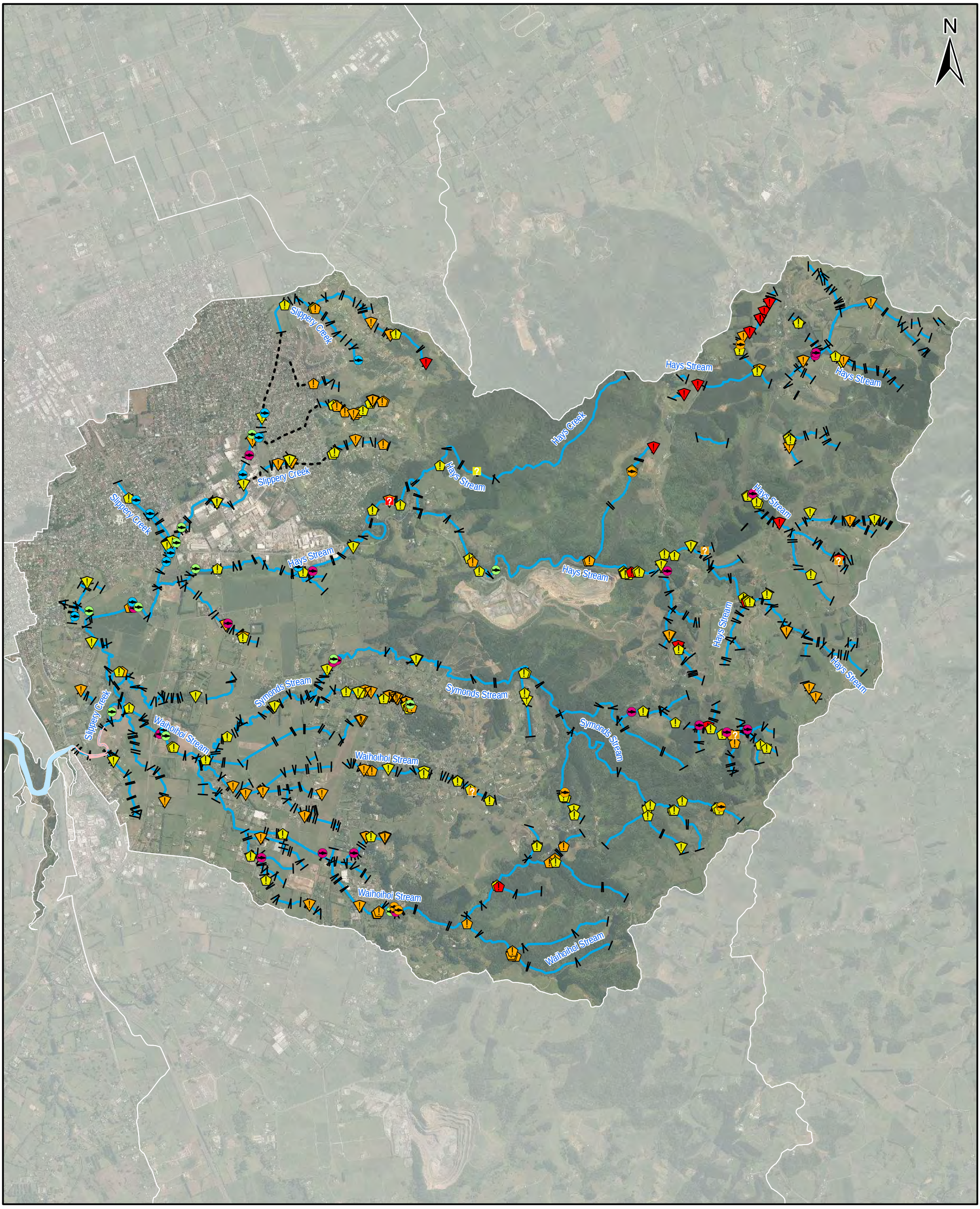
Map 6: Inanga Spawning, Fish Locations and Potential Barriers to Fish Passage



Fish Survey
- Anguilliform
- Climber
- Swimmer
- Exotic
- N.A.

NZFFDB
- Anguilliform
- Climber
- Swimmer
- Exotic
- N.A.

Nat. Barrier to:
- Anguilliforms
- Climbers
- Swimmers

Eng. Barrier to:
- Anguilliforms
- Climbers
- Swimmers

Misc. Barrier to:
- Anguilliform
- Climbers
- Swimmers

- Stream Mouth
- Inanga Spawning
- Piped Section

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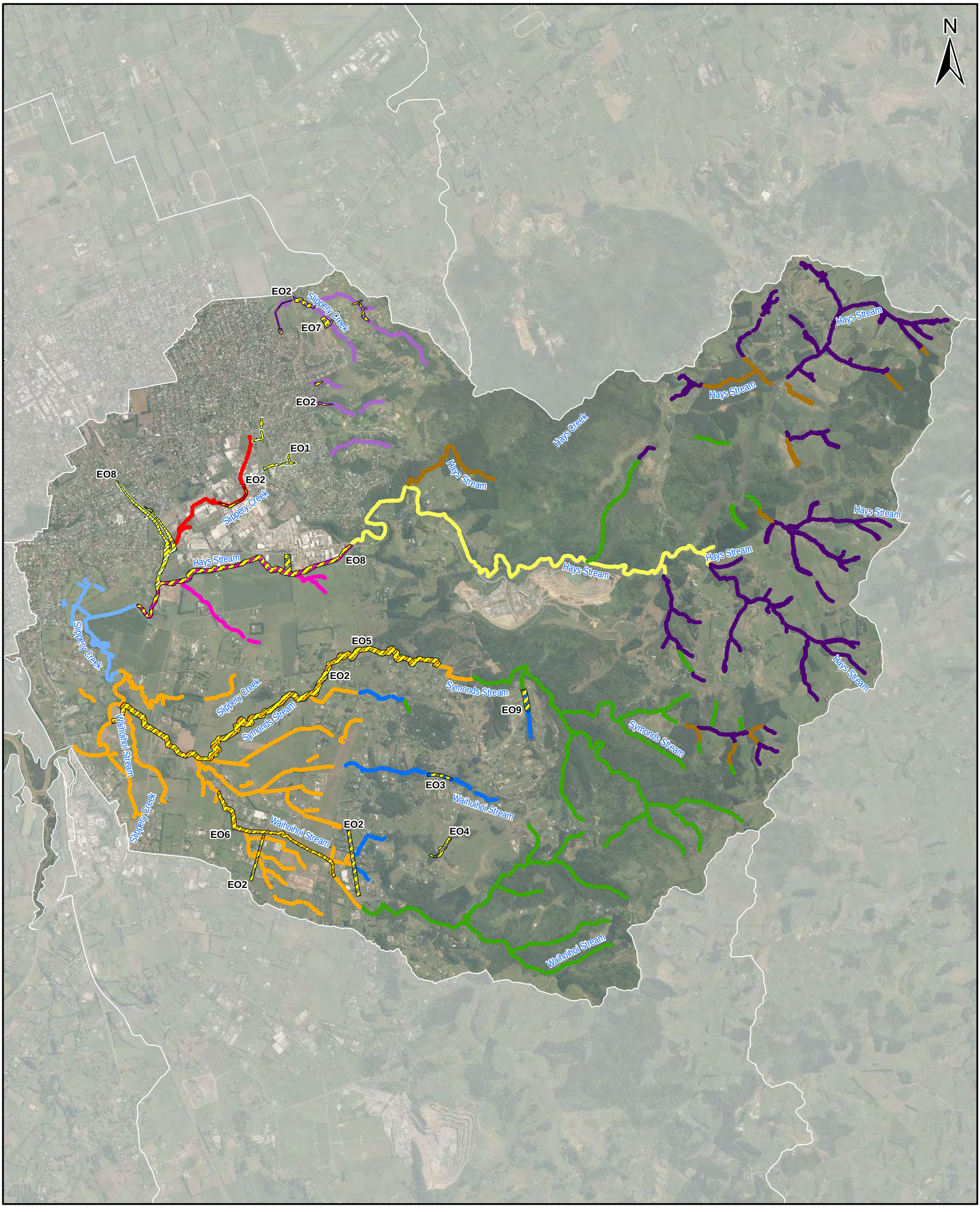
Map 7: Management Zones and Enhancement Opportunities



Management Zones

- MZ 1
- MZ 2
- MZ 3
- MZ 4
- MZ 5
- MZ 6
- MZ 7
- MZ 8
- MZ 9
- MZ 10
- MZ 11
- Enhancement Opportunities
- Stormwater Catchments

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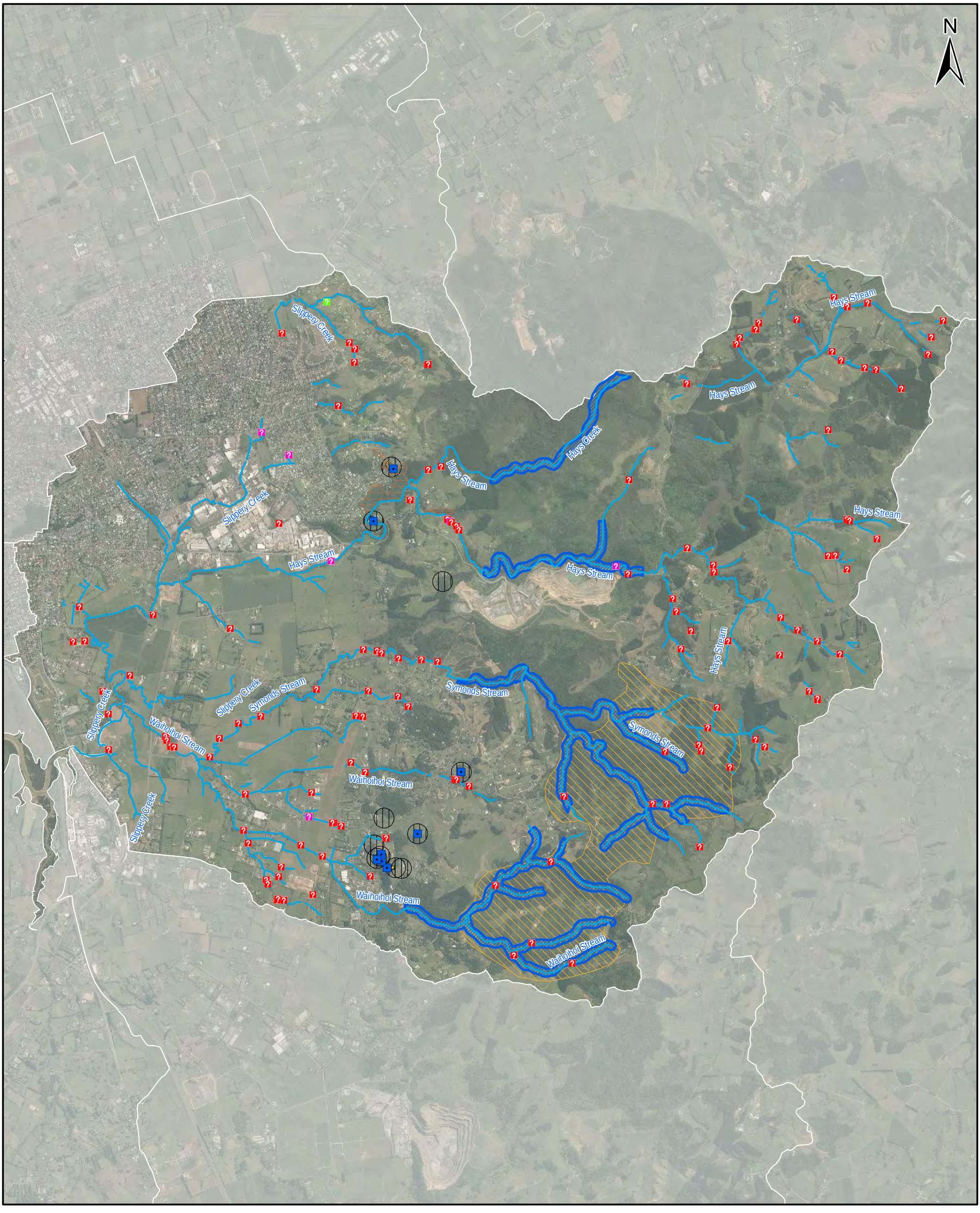
Map 8: Miscellaneous Features



Miscellaneous Points

- Tributary
- Pollution
- Weed Infestation
- Litter Dumping
- Historic Heritage
- Places Of Significance To Mana Whenua
- Natural Stream Management Area [rp]
- Coastal Natural Character Areas
- Outstanding Natural Features
- Outstanding Natural Landscape
- Places Of Value To Mana Whenua
- Historic Heritage Extent Of Place
- Stormwater Catchments

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Project: Slippery Creek WAR	
Project No: P00314	
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Sheet 8 of 8	Version: 1
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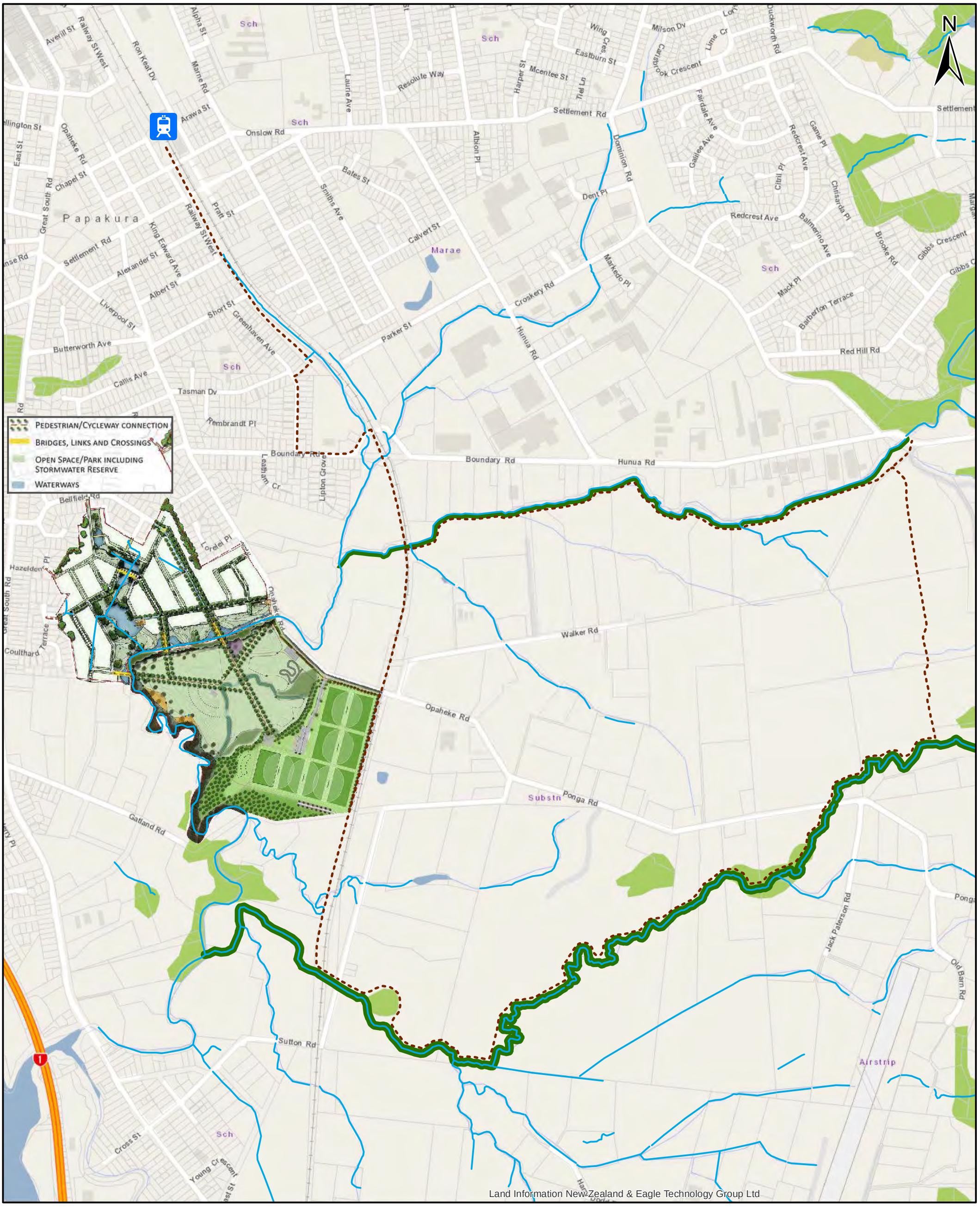
Waipokapu Cycle Way



Proposed Cycleway

Papakura Train station

Eco Line

Riparian Buffer

0 260 520

m

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Map Number:	Approved by: RI

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Appendix B SEV Results

	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10
Hydraulic										
Natural flow regime	0.93	0.96	0.83	0.48	0.49	0.65	0.85	0.91	0.94	1.00
Floodplain effectiveness	0.92	0.87	0.51	0.25	0.17	0.14	0.21	0.15	0.88	0.92
Connectivity for natural species migration	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Natural connectivity to groundwater	0.92	0.96	0.92	0.92	0.95	0.90	0.91	0.89	0.97	1.00
Mean score	***0.94***	***0.95***	***0.82***	***0.66***	***0.65***	***0.67***	***0.74***	***0.74***	***0.95***	***0.98***
Biogeochemical										
Water temperature control	0.92	0.64	0.74	0.48	0.68	0.78	0.66	0.72	0.76	0.94
Dissolved oxygen levels	0.60	1.00	0.60	0.40	0.68	0.60	0.68	1.00	1.00	1.00
Organic matter input	1.00	1.00	0.43	0.19	0.35	0.22	0.14	0.45	1.00	1.00
In-stream particle retention	0.91	0.94	0.75	0.36	0.48	0.52	0.82	0.86	0.95	0.99
Decontamination of pollutants	0.94	0.66	0.78	0.39	0.90	0.46	0.34	0.78	0.62	0.79
Mean score	***0.87***	***0.85***	***0.66***	***0.37***	***0.62***	***0.52***	***0.53***	***0.76***	***0.87***	***0.94***
Habitat Provision										
Fish spawning habitat	0.48	0.88	0.78	0.05	0.15	0.10	0.18	0.10	1.00	0.91
Habitat for aquatic fauna	0.86	0.83	0.74	0.36	0.60	0.56	0.66	0.72	0.87	0.92
Mean score	***0.67***	***0.85***	***0.76***	***0.21***	***0.38***	***0.33***	***0.44***	***0.41***	***0.94***	***0.96***
Biodiversity										
Fish fauna intact	0.60	0.27	0.43	0.43	0.33	0.33	0.43	0.67	0.63	0.37
Invertebrate fauna intact	0.81	0.47	0.34	0.22	0.29	0.57	0.59	0.38	0.64	0.26
Riparian vegetation intact	0.76	0.77	0.47	0.14	0.12	0.17	0.14	0.29	0.68	0.92
Mean score	***0.72***	***0.50***	***0.41***	***0.26***	***0.25***	***0.36***	***0.39***	***0.44***	***0.65***	***0.52***
SEV Value	**0.832**	**0.804**	**0.665**	**0.406**	**0.513**	**0.500**	**0.546**	**0.636**	**0.853**	**0.865**

Appendix C Engineering Maintenance Works Summary

Pipes and Culverts

Stream Name	Tributary Code	Asset ID	Asset Type	Material	GIS Record	Maintenance Type	Condition Rating	Land Ownership	Fish Barrier	Notes
Hays Stream	HAY_MAIN_15	UNK_091	Culvert	Concrete	Not in GIS	Erosion Protection	Average	Public	Swimmers	Could not locate inlet, unknown culvert length.
Hays Stream	HAY_MAIN_19	UNK_339	Pipe	Concrete	Not in GIS	None	Average	Private	Swimmers	Pipe through dam. Could not locate inlet.
Hays Stream	HAY_MAIN_29	UNK_110	Culvert	Concrete	Not in GIS	None	Good	Public	Does Not Apply	Culvert under road. Likely that inlet within quarry. High flow due to recent rainfall.
Hays Stream	HAY_MAIN_29	UNK_109	Culvert	Concrete	Not in GIS	Debris Removal	Average	Public	Does Not Apply	Culvert under road. No flow at time of survey. Could be overflow pipe or historic pipe. Could not locate inlet. Unknown culvert length.
Hays Stream	HAY_MAIN_36	UNK_103	Culvert	Concrete	Not in GIS	None	Good	Private	Swimmers	Culvert on TLB. Low velocity and insufficient water depth for swimmers at time of survey.
Hays Stream	HAY_MAIN_36	UNK_104	Culvert	Concrete	Not in GIS	None	Good	Private	Swimmers	Culvert on TRB. Pipe has little to no flow at time of survey and has a board across the inlet.
Hays Stream	HAY_MAIN_4	1133602	Pipe	Unknown	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Hays Stream	HAY_MAIN_43	UNK_082	Culvert	Concrete	Not in GIS	None	Good	Public	None	Culvert under road, wetland area upstream.
Hays Stream	HAY_MAIN_49	UNK_070	Culvert	Concrete	Not in GIS	None	Good	Public	None	Culvert under road, some sediment and plants along walls of pipe.
Hays Stream	HAY_MAIN_5	UNK_112	Pipe	Concrete	Not in GIS	Erosion Protection	Poor	Public	Does Not Apply	2.5 m of pipe visible coming out of bank. Last 2 m segment of pipe has coming away slightly resulting in flows coming out of this joint rather than the outlet itself.
Hays Stream	HAY_MAIN_5	UNK_113	Pipe	Concrete	Not in GIS	None	Good	Public	Does Not Apply	
Hays Stream	HAY_MAIN_9	1133644	Pipe	Concrete	Incorrect in GIS	Erosion Protection	Poor	Public	Does Not Apply	Severe erosion, erosion protection needed. Last segment of pipe has come away from the next section slightly. Shown as 225 mm in GIS. Correct diameter 275 mm.
Hays Stream	HAY_MAIN_9	UNK_092	Pipe	Concrete	Not in GIS	None	Average	Public	Does Not Apply	Lip of pipe broken.

Hays Stream	HAY_TRIB1_3	UNK_031	Culvert	Concrete	Not in GIS	Replacement	Poor	Private	None	Culvert under farm crossing. Outlet of culvert partially broken. Visible above ground with stock present.
Hays Stream	HAY_TRIB1_3	UNK_030	Culvert	Concrete	Not in GIS	None	Very good	Public	None	Culvert under road.
Hays Stream	HAY_TRIB1_4	UNK_032	Pipe	Polyvinyl Chloride	Not in GIS	None	Good	Public	Does Not Apply	Culvert under road. Smaller outlet in structure.
Hays Stream	HAY_TRIB1_5	UNK_033	Culvert	Concrete	Not in GIS	None	Very good	Private	Climbers	Culvert under bridge. Wetted margin of bank and rocks with steep gradient.
Hays Stream	HAY_TRIB1_8	UNK_035	Culvert	Concrete	Not in GIS	None	Average	Private	Climbers	Culvert draining from pond upstream. Exposed culvert in places.
Hays Stream	HAY_TRIB11_1	UNK_075	Culvert	Concrete	Not Located	Erosion Protection	Does Not Apply	Public	Anguilliforms	Culvert under road, block of concrete at outlet and in channel. Difficult access, limited information collected.
Hays Stream	HAY_TRIB12_1	UNK_076	Culvert	Concrete	Not in GIS	None	Good	Public	None	Culvert under road, slow flow, high sediment load in culvert.
Hays Stream	HAY_TRIB12_3	UNK_006	Culvert	Concrete	Not in GIS	None	Average	Private	Climbers	Culvert under farm crossing. Bank undercut 0.4 m at outlet. No wetted margin. Some overhanging vegetation.
Hays Stream	HAY_TRIB12_4	UNK_001	Culvert	Concrete	Not in GIS	Erosion Protection	Good	Private	Climbers	Scouring below outlet. No wetted margin. Bank undercut at outlet
Hays Stream	HAY_TRIB4_3	UNK_018	Culvert	Polyvinyl Chloride	Not in GIS	None	Average	Private	Anguilliforms	6 culverts draining from farm pond upstream. All perched 2.7 m above stream bed. 4 of 6 pipes had flow. Could see old concrete culvert broken on the stream bed. Wooden boards across stream further downstream. Limited upstream habitat.
Hays Stream	HAY_TRIB5_1	UNK_108	Culvert	Concrete	Not in GIS	None	Good	Private	Swimmers	Culvert perched 0.4 m above channel.
Hays Stream	HAY_TRIB5_2	UNK_101	Culvert	Concrete	Not in GIS	Vegetation Clearance	Average	Private	None	Culvert under road. Culvert is accumulating sediment.
Hays Stream	HAY_TRIB5_5	UNK_099	Culvert	Concrete	Not in GIS	None	Average	Private	Swimmers	Surface degradation to culvert outlet but not structurally compromised.
Hays Stream	HAY_TRIB5_5	UNK_038	Culvert	Concrete	Not in GIS	Erosion Protection	Average	Private	Climbers	Culvert perched above channel.
Hays Stream	HAY_TRIB5_6	UNK_026	Culvert	Concrete	Not in GIS	Erosion Protection	Average	Private	Anguilliforms	Perched culvert 1.6 m above stream. Farm crossing. Localised erosion.
Hays Stream	HAY_TRIB6_7	UNK_049	Culvert	Concrete	Not in GIS	Debris Removal	Poor	Private	Swimmers	Vegetation restricting flow at outlet causing overflow to culvert. Cascade over vegetation and culvert likely to be barrier to swimmers.

Hays Stream	HAY_TRIB6c_10	UNK_062	Culvert	Polyvinyl Chloride	Not in GIS	None	Good	Private	Anguilliforms	Perched culvert, high flow at time of survey. Old culvert has broken away, next drop is 1.5 m down to the stream bed, actively eroding.
Hays Stream	HAY_TRIB6c_6	UNK_063	Culvert	Concrete	Not in GIS	Erosion Protection	Average	Private	Anguilliforms	Perched culvert, high flow at time of survey. Looks to be a broken apron at bottom of outlet.
Hays Stream	HAY_TRIB6cl_5	UNK_017	Culvert	Concrete	Not in GIS	Erosion Protection	Average	Private	Climbers	Perched culvert. Scoured pool below 0.9 m deep.
Hays Stream	HAY_TRIB6cl_8	UNK_055	Culvert	Concrete	Not in GIS	None	Average	Private	Swimmers	Culvert under farm crossing. Little to no wetted margin especially in low flow.
Hays Stream	HAY_TRIB6cl1_1	UNK_056	Culvert	Concrete	Not in GIS	None	Average	Private	Swimmers	Culvert under farm crossing. Barrier to swimmers in summer when low flow.
Hays Stream	HAY_TRIB6e_5	UNK_333	Culvert	Concrete	Not in GIS	Patching	Average	Private	None	Timber post placed through middle of culvert. 1.2 m deep hole in middle of crossing. Slight drop in middle of culvert.
Hays Stream	HAY_TRIB6el_2	UNK_335	Culvert	Concrete	Not in GIS	Erosion Protection	Average	Private	Climbers	Perched culvert. Minor structural damage on top lip of culvert. Limited upstream habitat.
Hays Stream	HAY_TRIB6f_1	UNK_124	Culvert	Concrete	Not in GIS	Erosion Protection	Average	Public	Climbers	Down cutting from pipe outlet point. 1.6 m drop to stream channel. Degradation of pipe structure at outlet point.
Hays Stream	HAY_TRIB6f_4	UNK_125	Culvert	Concrete	Not Located	Debris Removal	Does Not Apply	Public	None	Culvert not located. Submerged at inlet and outlet. 0.3 m soft sediment by inlet. Stagnant water upstream. Evidence of water backing up upstream and flooding upper banks.
Hays Stream	HAY_TRIB6f_5	UNK_116	Culvert	Concrete	Not in GIS	Erosion Protection	Poor	Private	Climbers	Perched culvert, broken between pipe sections. Erosion around pipe outlet. Broken culverts below functioning culvert.
Hays Stream	HAY_TRIB6f_6	UNK_117	Culvert	Concrete	Not in GIS	Structural	Poor	Private	Anguilliforms	Perched culvert. Break between pipe sections, resulting in undercutting around outlet from underground flow. Pipe broken at outlet.
Hays Stream	HAY_TRIB6f_7	UNK_119	Culvert	Polyethylene	Not in GIS	Erosion Protection	Average	Private	Anguilliforms	Perched culvert at outlet of dam. Concrete debris below perched culvert acting as dissipating structure. Limited upstream habitat.

Hays Stream	HAY_TRIB6f_7	UNK_118	Culvert	Galvanised Iron or Steel	Not in GIS	Erosion Protection	Poor	Private	Anguilliforms	Perched culvert at outlet of dam. Concrete debris below perched culvert acting as dissipating structure. Limited upstream habitat.
Hays Stream	HAY_TRIB6f_8	UNK_120	Culvert	Concrete	Not in GIS	Structural	Poor	Private	Anguilliforms	Perched culvert. Break between pipe sections. Dry Culvert. Flow is below culvert resulting in undercutting around outlet.
Hays Stream	HAY_TRIB6f_9	UNK_121	Culvert	Concrete	Not in GIS	Structural	Poor	Private	Does Not Apply	Perched culvert. Small break between pipe sections, some flow appears to be going beneath the culvert which is causing erosion around the pipe outlet.
Hays Stream	HAY_TRIB6fI_2	UNK_019	Culvert	Concrete	Not in GIS	Structural	Poor	Private	Anguilliforms	Culvert under farm crossing. Culvert has broken off due to major undercutting under culvert on outlet end. Major land slips into stream. Broken section of culvert is approximately 1.5 m long. Section of culvert also broken half way along crossing.
Hays Stream	HAY_TRIB6fI_3	UNK_021	Culvert	Concrete	Not in GIS	None	Good	Private	Anguilliforms	Culvert under farm crossing. Perched 0.65 m above channel. Likely no flow in summer so barrier to all fish.
Hays Stream	HAY_TRIB6fII_1	UNK_122	Culvert	Concrete	Not in GIS	Structural	Average	Private	Anguilliforms	Perched culvert. Break between pipe sections resulting in erosion at the pipe outfall.
Hays Stream	HAY_TRIB6g_2	UNK_024	Culvert	Concrete	Not in GIS	Replacement	Poor	Private	None	Pipe broken at inlet point. Slight erosion on true right of pipe
Hays Stream	HAY_TRIB6i_1	UNK_057	Culvert	Concrete	Not in GIS	None	Good	Public	Does Not Apply	Culvert under road. High flow of water after recent rainfall. Could not locate outlet, unsure if barrier exists.
Hays Stream	HAY_TRIB6j_3	UNK_011	Culvert	Concrete	Not in GIS	None	Good	Private	Swimmers	Culvert under farm crossing. Some overhanging vegetation.
Hays Stream	HAY_TRIB6j_4	UNK_012	Culvert	Concrete	Not in GIS	None	Average	Private	Climbers	Culvert under farm crossing. No wetted margin and little overhanging vegetation. Culvert top broken at outlet.
Hays Stream	HAY_TRIB6j_7	UNK_015	Culvert	Unknown	Not in GIS	Erosion Protection	Good	Private	Does Not Apply	Perched culvert with no upstream habitat. Condition and material unknown.
Hays Stream	HAY_TRIB6j_8	UNK_016	Culvert	Galvanised Iron or Steel	Not in GIS	Replacement	Very Poor	Private	None	Culvert broken at outlet due to collapse from bridge structure above. Inlet of culvert is bent down on top lip.

Hays Stream	HAY_TRIB6k_2	UNK_004	Culvert	Concrete	Not in GIS	None	Poor	Private	Climbers	Culvert difficult to access. No wetted margin or overhanging vegetation. Top of culvert at outlet end is broken and cracked. Undercut bank 0.3 m at outlet.
Slippery Creek	SLI_MAIN_1	1133658	Pipe	Unknown	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_1	1133657	Pipe	Unknown	Not Located	Does Not Apply	Does Not Apply	Private	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_15	UNK_172	Culvert	Concrete	Not in GIS	None	Good	Private	Swimmers	Culvert connecting smaller tributary to main.
Slippery Creek	SLI_MAIN_17	UNK_165	Pipe	Concrete	Not in GIS	Erosion Protection	Good	Private	Does Not Apply	Erosion protection required. No upstream habitat.
Slippery Creek	SLI_MAIN_21	1133597	Pipe	Concrete	Correct in GIS	Erosion Protection	Poor	Public	Does Not Apply	Lip of pipe broken. Erosion on bank around outlet. Erosion protection required.
Slippery Creek	SLI_MAIN_25	1133534	Pipe	Concrete	Correct in GIS	Vegetation Clearance	Average	Public	Does Not Apply	Vegetation growing over outlet.
Slippery Creek	SLI_MAIN_25	1133537	Pipe	Unknown	Not Located	Does Not Apply	Does Not Apply	Private	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_25	1133538	Pipe	Unknown	Not Located	Does Not Apply	Does Not Apply	Private	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_26	1133506	Pipe	Unknown	Not Located	Does Not Apply	Does Not Apply	Private	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_27	1133501	Culvert	Concrete	Correct in GIS	None	Good	Public	Swimmers	
Slippery Creek	SLI_MAIN_27	1133517	Pipe	Concrete	Incorrect in GIS	None	Good	Public	Does Not Apply	Incorrect in GIS. Shown as 225 mm. Correct diameter is 1050 mm.
Slippery Creek	SLI_MAIN_27	1129202	Culvert	Concrete	Correct in GIS	None	Good	Public	Swimmers	
Slippery Creek	SLI_MAIN_28	UNK_173	Pipe	Concrete	Not in GIS	None	Good	Public	Does Not Apply	
Slippery Creek	SLI_MAIN_29	1132831	Pipe	Concrete	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_29	1134828	Culvert	Corrugated Iron	Incorrect in GIS	None	Good	Public	None	Incorrect in GIS. Material listed as concrete. Correct material is Corrugated Iron.
Slippery Creek	SLI_MAIN_29	1132893	Pipe	Concrete	Incorrect in GIS	None	Good	Public	Does Not Apply	Incorrect in GIS. Shown as 525 mm. Correct diameter is 675 mm.
Slippery Creek	SLI_MAIN_29	UNK_176	Pipe	Concrete	Not in GIS	None	Good	Public	Does Not Apply	
Slippery Creek	SLI_MAIN_29	1132830	Culvert	Corrugated Iron	Incorrect in GIS	None	Good	Public	None	Incorrect in GIS. Material listed as concrete. Correct material Corrugated Iron.

Slippery Creek	SLI_MAIN_29	1134829	Culvert	Corrugated Iron	Incorrect in GIS	None	Good	Public	None	Incorrect in GIS. Material listed as concrete. Correct material Corrugated Iron.
Slippery Creek	SLI_MAIN_30	1132816	Pipe	Concrete	Correct in GIS	Debris Removal	Average	Public	Does Not Apply	Debris covering outlet.
Slippery Creek	SLI_MAIN_30	UNK_175	Pipe	Polyethylene	Not in GIS	Debris Removal	Good	Public	Does Not Apply	Vegetation growing below and around pipe.
Slippery Creek	SLI_MAIN_31	1182438	Pipe	Concrete	Incorrect in GIS	None	Good	Public	Does Not Apply	Incorrect in GIS for material. Material null in GIS.
Slippery Creek	SLI_MAIN_31	1132769	Culvert	Concrete	Correct in GIS	None	Good	Public	Climbers	
Slippery Creek	SLI_MAIN_31	UNK_341	Pipe	Concrete	Not in GIS	Debris Removal	Poor	Public	Does Not Apply	Pipe filled with debris. Possibly abandoned.
Slippery Creek	SLI_MAIN_31	1132779	Pipe	Concrete	Correct in GIS	Erosion Protection	Good	Public	Does Not Apply	Approx. 100 mm of sediment in pipe. Erosion protection required.
Slippery Creek	SLI_MAIN_31	UNK_132	Pipe	Concrete	Not in GIS	None	Good	Public	Does Not Apply	
Slippery Creek	SLI_MAIN_32	1134138	Pipe	Concrete	Correct in GIS	None	Good	Public	Swimmers	Pipe connects to grated manhole in pond that drains flow from pond. Manhole creates a complete barrier to swimmers.
Slippery Creek	SLI_MAIN_32	1134149	Pipe	Concrete	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_32	UNK_174	Pipe	Concrete	Not in GIS	None	Good	Public	Does Not Apply	
Slippery Creek	SLI_MAIN_32	1134147	Pipe	Polyvinyl Chloride	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_33	1131138	Pipe	Concrete	Incorrect in GIS	None	Good	Private	None	Grated steel cover over pipe. Shown as 300 mm in GIS. Correct diameter is 600 mm.
Slippery Creek	SLI_MAIN_34	1134271	Culvert	Concrete	Correct in GIS	None	Good	Private	Anguilliforms	High flow at time of survey causing fish barrier.
Slippery Creek	SLI_MAIN_39	UNK_162	Pipe	Polyvinyl Chloride	Not in GIS	Erosion Protection	Average	Private	Does Not Apply	Erosion protection needed to prevent further degradation and slumping of banks.
Slippery Creek	SLI_MAIN_39	UNK_163	Pipe	Concrete	Not in GIS	Erosion Protection	Average	Private	Does Not Apply	Erosion protection needed to prevent further erosion and undercutting of banks.
Slippery Creek	SLI_MAIN_39	1134434	Pipe	Concrete	Not Located	Does Not Apply	Does Not Apply	Private	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_40	1134433	Culvert	Concrete	Correct in GIS	Debris Removal	Good	Private	Swimmers	Sediment deposition within culvert resulting in flooding risk and temporal fish passage barrier for swimmers.
Slippery Creek	SLI_MAIN_42	UNK_158	Culvert	Concrete	Not in GIS	None	Average	Private	Climbers	Perched culvert under farm crossing.

Slippery Creek	SLI_MAIN_45	UNK_159	Culvert	Concrete	Not in GIS	None	Average	Private	Climbers	Perched culvert under driveway.
Slippery Creek	SLI_MAIN_47	UNK_157	Culvert	Polyvinyl Chloride	Not in GIS	None	Good	Private	Anguilliforms	Perched culvert from pond. Limited upstream habitat.
Slippery Creek	SLI_TRIB1_2	UNK_336	Culvert	Concrete	Not in GIS	None	Good	Public	Swimmers	Slight erosion at outlet, lip of culvert above water surface at time of survey likely perched up to 0.2 m in low flow.
Slippery Creek	SLI_TRIB1_2	1133681	Pipe	Concrete	Incorrect in GIS	None	Good	Private	Does Not Apply	Diameter and material listed as unknown on GIS.
Slippery Creek	SLI_TRIB10_1	1132697	Pipe	Concrete	Incorrect in GIS	None	Good	Private	None	Shown in GIS as 225 mm diameter. Correct diameter is 1050 mm.
Slippery Creek	SLI_TRIB10_1	1132689	Culvert	Concrete	Incorrect in GIS	None	Good	Private	None	Shown in GIS as 225mm diameter. Culvert under driveway. Correct diameter is 1800 mm.
Slippery Creek	SLI_TRIB12_3	1136901	Pipe	Concrete	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB12_6	1134031	Pipe	Concrete	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB2_2	UNK_128	Culvert	Cast Iron	Not in GIS	None	Good	Private	Climbers	Culvert under farm crossing. Scoured erosion around outlet.
Slippery Creek	SLI_TRIB3_10	UNK_136	Culvert	Concrete	Not in GIS	Replacement	Poor	Private	None	Pipe broken up into several pieces and obstructed by blackberry.
Slippery Creek	SLI_TRIB3_9	UNK_153	Culvert	Concrete	Not in GIS	Replacement	Poor	Private	None	Pipe appears to be buried at inlet point. Culvert partially dug out. Flow passing over top.
Slippery Creek	SLI_TRIB3a_1	UNK_155	Culvert	Unknown	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate culvert. Either submerged, or buried.
Slippery Creek	SLI_TRIB4_FORK1_1	1133480	Pipe	Concrete	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB4_FORK1_2	1133468	Pipe	Unknown	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey outlet and therefore pipe.
Slippery Creek	SLI_TRIB4_FORK1_3	UNK_169	Culvert	Concrete	Not in GIS	None	Good	Private	Swimmers	Culvert under farm crossing.
Slippery Creek	SLI_TRIB4_FORK1_4	1133460	Pipe	Concrete	Incorrect in GIS	None	Good	Private	Does Not Apply	Shown in GIS as 225mm diameter. Correct diameter is 700 mm.
Slippery Creek	SLI_TRIB4_FORK1a_1	1133467	Pipe	Concrete	Incorrect in GIS	None	Good	Private	Does Not Apply	Shown in GIS as 225mm diameter. Correct diameter is 750 mm.
Slippery Creek	SLI_TRIB4_FORK2_1	1133484	Culvert	Concrete	Correct in GIS	Structural	Poor	Private	None	Outlet fully submerged under water. Outlet broken off.
Slippery Creek	SLI_TRIB4_FORK2a_1	1133489	Pipe	Concrete	Incorrect in GIS	None	Good	Private	Does Not Apply	Shown in GIS as 225mm diameter. Correct diameter is 300 mm.
Slippery Creek	SLI_TRIB4_FORK2a_1	1133485	Pipe	Concrete	Correct in GIS	Vegetation Clearance	Good	Private	Does Not Apply	Outlet completely covered by vegetation.

Slippery Creek	SLI_TRIB5_1	UNK_179	Culvert	Concrete	Not in GIS	Structural	Average	Public	None	Displacement of joint in the centre of the culvert. Material starting to come through.
Slippery Creek	SLI_TRIB5_2	UNK_180	Culvert	Concrete	Not in GIS	None	Good	Public	Swimmers	Culvert under stream crossing.
Slippery Creek	SLI_TRIB5_3	UNK_181	Culvert	Concrete	Not in GIS	None	Good	Public	None	Culvert under road. Vegetation across outlet but not affecting flow.
Slippery Creek	SLI_TRIB5_7	1135544	Pipe	Concrete	Correct in GIS	Debris Removal	Poor	Public	Does Not Apply	Pipe blocked full of sediment.
Slippery Creek	SLI_TRIB5a_1	1133550	Pipe	Concrete	Correct in GIS	Structural	Average	Public	Does Not Apply	Lip of pipe broken.
Slippery Creek	SLI_TRIB6_2	UNK_182	Culvert	Concrete	Not in GIS	None	Good	Public	None	Culvert under road.
Slippery Creek	SLI_TRIB6_3	1133542	Pipe	Unknown	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB7_2	1129279	Pipe	Concrete	Incorrect in GIS	None	Good	Private	Does Not Apply	GIS information lacks dimensions.
Slippery Creek	SLI_TRIB8_1	1132581	Pipe	Concrete	Correct in GIS	Vegetation Clearance	Good	Public	Does Not Apply	Vegetation covering outlet.
Slippery Creek	SLI_TRIB9_1	UNK_147	Pipe	Concrete	Not in GIS	None	Good	Public	Does Not Apply	
Slippery Creek	SLI_TRIB9_10	UNK_140	Culvert	Concrete	Not in GIS	Erosion Protection	Average	Private	Climbers	Farm culvert. Erosion protection required to prevent further undercutting of bank.
Slippery Creek	SLI_TRIB9_12	1133841	Pipe	Polyvinyl Chloride	Not Located	Does Not Apply	Does Not Apply	Private	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB9_12	1133842	Pipe	Concrete	Not Located	Does Not Apply	Does Not Apply	Private	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB9_2	UNK_144	Culvert	Concrete	Not in GIS	Erosion Protection	Good	Public	Climbers	Culvert under stream crossing. Erosion protection required to stop the undercutting of the true left bank.
Slippery Creek	SLI_TRIB9_2	1132844	Pipe	Concrete	Incorrect in GIS	None	Average	Public	Does Not Apply	Lip of pipe broken. Shown in GIS as 225 mm. Correct diameter is 300 mm.
Slippery Creek	SLI_TRIB9_2	1132864	Pipe	Concrete	Incorrect in GIS	None	Good	Public	Does Not Apply	Pipe material shown in GIS as unknown.
Slippery Creek	SLI_TRIB9_3	1132835	Pipe	Concrete	Incorrect in GIS	Erosion Protection	Average	Public	Does Not Apply	Lip of pipe broken. Erosion protection needed to stop undercutting of apron/pipe. Shown in GIS as 225 mm. correct diameter is 150 mm.
Slippery Creek	SLI_TRIB9_4	1132843	Pipe	Concrete	Incorrect in GIS	None	Good	Public	Does Not Apply	Pipe shown as 225 mm on GIS. Correct diameter is 375 mm.
Slippery Creek	SLI_TRIB9_5	UNK_145	Culvert	Concrete	Not in GIS	None	Good	Public	Climbers	Culvert under stream crossing.
Slippery Creek	SLI_TRIB9a_2	UNK_146	Culvert	Concrete	Not in GIS	None	Good	Public	Swimmers	Culvert under stream crossing.

Slippery Creek	SLI_TRIB9a_2	1132820	Pipe	Concrete	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Symonds Stream	SYM_MAIN_12	UNK_205	Culvert	Concrete Lined Steel	Not in GIS	Replacement	Poor	Private	Swimmers	Cracked and broken pipe in stream bed. Pipe partially filled with sediment. Small connection. Partially blocked with debris at inlet point.
Symonds Stream	SYM_MAIN_19	UNK_214	Culvert	Concrete	Not in GIS	None	Average	Public	None	Culvert on true right, secondary flow, likely no water in summer.
Symonds Stream	SYM_MAIN_19	UNK_215	Culvert	Concrete	Not in GIS	None	Average	Public	None	Culvert on true left.
Symonds Stream	SYM_MAIN_22	UNK_227	Culvert	Concrete	Not in GIS	None	Good	Private	Swimmers	0.15 m lip between culvert and concrete apron.
Symonds Stream	SYM_MAIN_22	UNK_228	Culvert	Concrete	Not in GIS	None	Good	Private	Swimmers	0.15 m lip between culvert and concrete apron.
Symonds Stream	SYM_MAIN_FORK1_TRIB1_3	UNK_184	Culvert	Steel	Not in GIS	Debris Removal	Average	Private	Swimmers	Roots and tree debris immediately downstream of culvert. Culvert under driveway.
Symonds Stream	SYM_MAIN_FORK1_TRIB2_3	UNK_183	Culvert	Other	Not in GIS	Replacement	Poor	Private	Swimmers	Farm culvert made from old tyres. Low quality upstream habitat. Bedload and sediment within tyres. Wetted margin of banks and tyre.
Symonds Stream	SYM_MAIN_FORK2_10	UNK_211	Culvert	Galvanised Iron or Steel	Not in GIS	Erosion Protection	Average	Private	Anguilliforms	Culvert undercut almost 1 m and perched above channel.
Symonds Stream	SYM_TRIB1a_4	UNK_216	Culvert	Concrete	Not in GIS	Debris Removal	Good	Private	None	Willow obstructing flow at inlet.
Symonds Stream	SYM_TRIB1a_5	UNK_217	Culvert	Concrete	Not in GIS	Patching	Average	Private	None	Culvert under driveway. High sediment loading in culvert.
Symonds Stream	SYM_TRIB1aII_2	UNK_203	Culvert	Concrete	Not in GIS	None	Good	Public	None	Culvert under road.
Symonds Stream	SYM_TRIB1aII_2	UNK_204	Culvert	Concrete	Not in GIS	None	Good	Public	None	Culvert under road.
Symonds Stream	SYM_TRIB1aII_2	UNK_201	Culvert	Concrete	Not in GIS	Patching	Average	Private	Climbers	Culvert under farm crossing. No wetted margin and limited overhanging vegetation. Culvert undercut below outlet.
Symonds Stream	SYM_TRIB1aII_2	UNK_202	Culvert	Polyvinyl Chloride	Not in GIS	None	Good	Public	Climbers	Culvert under road. No continuous wetted margin. Little to no flow.
Symonds Stream	SYM_TRIB2_10	UNK_196	Culvert	Concrete	Not in GIS	Replacement	Poor	Private	Climbers	Culvert under farm crossing. No wetted margin and eroded high steep banks. Clay and rocks allow anguilliforms to pass. Culvert broken half way under farm crossing.

Symonds Stream	SYM_TRIB2_10	UNK_195	Culvert	Concrete	Not in GIS	Replacement	Poor	Private	Climbers	Culvert under farm crossing. No wetted margin and eroded high steep banks, clay and rocks allow anguilliforms to pass. Culvert broken half way under farm crossing.
Symonds Stream	SYM_TRIB2_11	UNK_219	Culvert	Concrete	Not in GIS	None	Average	Private	Climbers	Pipe uncovered approx. 5 m from stream
Symonds Stream	SYM_TRIB2_11	UNK_197	Culvert	Concrete	Not in GIS	Patching	Poor	Private	Climbers	Culvert under road. Bank undercut below outlet causing drop.
Symonds Stream	SYM_TRIB2_13	UNK_193	Culvert	Concrete	Not in GIS	None	Good	Private	Climbers	Undercut outlet extending 0.15 m from bank .
Symonds Stream	SYM_TRIB2_13	UNK_192	Culvert	Concrete	Not in GIS	Erosion Protection	Average	Private	Climbers	Erosion and undercutting of outlet. Small wetted margin. Little to no flow.
Symonds Stream	SYM_TRIB2_14	UNK_194	Culvert	Concrete	Not in GIS	Erosion Protection	Good	Private	Climbers	Dry culvert
Symonds Stream	SYM_TRIB2_4	UNK_200	Culvert	Concrete	Not in GIS	None	Good	Public	None	Culvert under road. Could not locate outlet. Image was not possible.
Symonds Stream	SYM_TRIB2_6	UNK_212	Culvert	Concrete	Not in GIS	Vegetation Clearance	Good	Public	Swimmers	Culvert almost completely blocked at outlet by willow roots.
Symonds Stream	SYM_TRIB2_7	UNK_198	Culvert	Concrete	Not in GIS	None	Good	Private	Climbers	Culvert under farm crossing. No wetted margin for climbers with loose grasses overhanging. Top of culvert can be seen under farm crossing due to livestock use.
Symonds Stream	SYM_TRIB2_8	UNK_199	Culvert	Concrete	Not in GIS	Erosion Protection	Good	Private	Climbers	Culvert under farm crossing.
Symonds Stream	SYM_TRIB3_2	UNK_225	Culvert	Concrete	Not in GIS	Patching	Poor	Private	Swimmers	Perched culvert. Gap between two pipe sections.
Waihoihoi Stream	WAI_MAIN_11	UNK_300	Culvert	Concrete	Not in GIS	None	Good	Public	None	Gravels in culvert but looks like the natural bed of the stream. Some dry gravel present on TRB.
Waihoihoi Stream	WAI_MAIN_18	UNK_338	Culvert	Corrugated Iron	Not in GIS	None	Good	Public	None	Culvert under road. Lower part of culvert is concrete lined.
Waihoihoi Stream	WAI_TRIB1_5	UNK_234	Culvert	Concrete	Not in GIS	None	Good	Public	None	Culvert under road.
Waihoihoi Stream	WAI_TRIB1_7	UNK_238	Culvert	Concrete	Not in GIS	None	Average	Public	None	Culvert under railway. Could not locate outlet.
Waihoihoi Stream	WAI_TRIB2_15	UNK_248	Culvert	Concrete	Not in GIS	None	Very good	Public	None	Culvert Under road (or private driveway).
Waihoihoi Stream	WAI_TRIB2_17	UNK_330	Culvert	Concrete	Not in GIS	Patching	Average	Private	Swimmers	Stream flowing under culvert, no water on culvert at time of survey. Hard bottom stream with boulders and cobbles, no apparent erosion at inlet or outlet.

Waihoihoi Stream	WAI_TRIB2_19	UNK_242	Culvert	Concrete	Not in GIS	None	Good	Private	Swimmers	Culvert under farm crossing. Dissipating rocks beneath outlet provide wetted margin for climbers.
Waihoihoi Stream	WAI_TRIB2_4	UNK_272	Culvert	Concrete	Not in GIS	None	Average	Private	Climbers	Culvert leading from farm wetland. Bank undercut 0.4 m. Under cutting at outlet point. Boulder placed at base to reduce scour.
Waihoihoi Stream	WAI_TRIB2_4	UNK_271	Culvert	Concrete	Not in GIS	None	Average	Public	Does Not Apply	Culvert under road. Slight cracking of culvert outlet. No upstream habitat as culvert drains from road.
Waihoihoi Stream	WAI_TRIB2_5	UNK_275	Culvert	Concrete	Not in GIS	None	Good	Private	Climbers	Unmarked tributary. Culvert under farm crossing. Wetted margin and vegetation exists for climbers in high flows. Metal wheel placed on outlet.
Waihoihoi Stream	WAI_TRIB2b_2	UNK_280	Culvert	Concrete	Not in GIS	None	Good	Private	Climbers	Culvert under driveway. Boulder at base of stream bed to decrease scouring. Erosion of banks underneath culvert at inlet and outlet.
Waihoihoi Stream	WAI_TRIB2b_4	UNK_281	Culvert	Concrete	Not in GIS	Replacement	Poor	Private	None	Culvert under farm crossing. Cracked and broken in half, fallen in on itself. Broken part on outlet side.
Waihoihoi Stream	WAI_TRIB2b_6	UNK_250	Culvert	Concrete	Not in GIS	None	Average	Private	Climbers	Could not locate inlet. Likely on other side of airfield. Upstream habitat/upstream network barrier unknown. Dry culvert.
Waihoihoi Stream	WAI_TRIB2bI_4	UNK_252	Culvert	Concrete	Not in GIS	Structural	Average	Public	Climbers	No wetted margin exists for climbers. Anguilliforms may be able to move through grassy vegetation. Water trickling below outlet rather than through.
Waihoihoi Stream	WAI_TRIB5_14	UNK_331	Culvert	Concrete	Not in GIS	None	Average	Public	Climbers	Uncertain if flow all year round. Culvert under road.
Waihoihoi Stream	WAI_TRIB5_3	UNK_332	Culvert	Polyvinyl Chloride	Not in GIS	Replacement	Average	Private	None	Small culvert under private driveway. Erosion on true right bank indicated culvert may be undersized.
Waihoihoi Stream	WAI_TRIB5_4	UNK_320	Culvert	Concrete	Not in GIS	None	Good	Public	None	Culvert under road.
Waihoihoi Stream	WAI_TRIB5a_1	UNK_325	Culvert	Concrete	Not in GIS	None	Average	Private	Climbers	Perched culvert.
Waihoihoi Stream	WAI_TRIB5a_1	UNK_321	Culvert	Concrete	Not in GIS	Debris Removal	Good	Public	None	Culvert requires debris removal at the inlet.
Waihoihoi Stream	WAI_TRIB7_4	UNK_283	Culvert	Concrete	Not in GIS	None	Good	Public	None	Culvert under road.

Waihoihoi Stream	WAI_TRIB7_6	UNK_284	Culvert	Concrete	Not in GIS	None	Good	Private	Climbers	Inlet diameter 750 mm. Outlet diameter 860 mm. During High flow climber may be able to get up. Small Debris jam at inlet.
Waihoihoi Stream	WAI_TRIB7_6	UNK_285	Culvert	Concrete	Not in GIS	None	Good	Private	Climbers	Inlet diameter 750 mm. Outlet 850 mm. During high flows some climbers may be able to climb.
Waihoihoi Stream	WAI_TRIB7_7	UNK_288	Culvert	Concrete	Not in GIS	None	Good	Private	Climbers	Bank lining immediately downstream of culvert on true right bank.
Waihoihoi Stream	WAI_TRIB7_7	UNK_287	Culvert	Concrete	Not in GIS	None	Good	Private	Climbers	Bank lining immediately downstream of culvert on true right bank. No flow at time of survey.
Waihoihoi Stream	WAI_TRIB7a_2	UNK_282	Culvert	Concrete	Not in GIS	None	Good	Public	None	Culvert under road.

Inlets/Outlets

Stream Name	Tributary Code	Asset ID	Asset Type	Structure Material	GIS Record	Maintenance Type	Erosion	Land Ownership	Fish Barrier	Notes
Slippery Creek	SLI_TRIB5_6	1114909	Standard Outlet (Headwall and Wingwalls)	Concrete	Correct in GIS	None	Slight	Public	Does Not Apply	Concrete on head wall around pipe breaking away. Gabion baskets also acting as dissipation after apron. Sewage fungus present.
Slippery Creek	SLI_TRIB4_FORK1_4	1115058	Standard Outlet (Headwall and Wingwalls)	Concrete	Correct in GIS	Structural	None	Private	Does Not Apply	Concrete breaking away from wing walls.
Slippery Creek	SLI_TRIB4_FORK1_2	1115062	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Private	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB4_FORK1_1	1115070	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Private	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB4_FORK2a_1	1115075	Standard Outlet (Headwall and Wingwalls)	Concrete	Correct in GIS	Vegetation Clearance	None	Private	Does Not Apply	Structure completely covered by vegetation.
Slippery Creek	SLI_MAIN_26	1115089	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_25	1115107	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_25	1115108	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB5a_1	1115109	Outlet point (no structure)	None	Correct in GIS	Structural	Slight	Public	Does Not Apply	Apron is partially broken away. No upstream habitat
Slippery Creek	SLI_TRIB6_3	1115112	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_31	1115153	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_31	1115158	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_30	1115188	Standard Inlet (Headwall and Wingwalls)	Masonry Block	Correct in GIS	Debris Removal	Slight	Public	None	Debris covering structure and outlet. Should be removed.
Slippery Creek	SLI_TRIB9a_2	1115190	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_29	1115196	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB9_3	1115199	Outlet point (no structure)	None	Correct in GIS	Does Not Apply	Moderate	Public	Does Not Apply	Remnants of historic apron, now functioning as a standard outlet.

Slippery Creek	SLI_MAIN_29	1115229	Standard Outlet (Headwall and Wingwalls)	Masonry Block	Correct in GIS	Erosion Protection	Moderate	Public	Does Not Apply	Recommend some erosion protection i.e. rock is installed down bank to stream.
Slippery Creek	SLI_MAIN_28	1115254	Standard Outlet (Headwall and Wingwalls)	Masonry Block	Correct in GIS	None	Slight	Public	Swimmers	Small lip on edge of apron, deep pool at base.
Slippery Creek	SLI_MAIN_21	1115547	Outlet point (no structure)	None	Correct in GIS	Does Not Apply	Moderate	Public	Does Not Apply	
Hays Stream	HAY_MAIN_4	1115548	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey. Dense vegetation.
Hays Stream	HAY_MAIN_9	1115574	Outlet point (no structure)	None	Correct in GIS	Does Not Apply	Severe	Public	Does Not Apply	Severe erosion around outlet and down bank to stream. Erosion cut into bank approx. 2 m as well as undercutting the bank and pipe approx. 1.5 m.
Slippery Creek	SLI_MAIN_1	1115589	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB12_6	1115775	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey. Dense vegetation.
Slippery Creek	SLI_MAIN_32	1115824	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_34	1115847	Standard Outlet (Headwall and Wingwalls)	Concrete	Correct in GIS	None	Slight	Private	Anguilliforms	High flow at time of survey causing temporary barrier. Masonry block that is acting as wing wall on TRB is being undercut and has broken as a result.
Slippery Creek	SLI_MAIN_32	1115939	Inlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_MAIN_39	1116030	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Private	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB9_12	1116046	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Private	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB9_12	1116047	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey.
Slippery Creek	SLI_TRIB5_6	1116832	Standard Outlet (Headwall and Wingwalls)	Concrete	Correct in GIS	Structural	Slight	Public	Does Not Apply	Headwall and wingwall. No Apron. Structure has broken away from pipe. Unable to see or access pipe. Structure should be replaced.
Slippery Creek	SLI_TRIB12_3	1116928	Outlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Public	Does Not Apply	Could not locate/survey. Gorse bush.
Slippery Creek	SLI_TRIB5_1	UNK_001	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under farm crossing.
Slippery Creek	SLI_TRIB5_1	UNK_002	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	
Slippery Creek	SLI_TRIB5_2	UNK_003	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under farm crossing.

Slippery Creek	SLI_TRIB5_2	UNK_004	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	
Slippery Creek	SLI_TRIB5_2	UNK_005	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	
Slippery Creek	SLI_TRIB5_3	UNK_006	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road.
Slippery Creek	SLI_TRIB6_1	UNK_007	Outlet point (no structure)	None	Not in GIS	None	None	Public	Swimmers	Culvert under road.
Slippery Creek	SLI_TRIB6_2	UNK_008	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road.
Slippery Creek	SLI_TRIB5_5	UNK_010	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Public	Does Not Apply	New outlet that looks to be for developments that are in progress. Does not look to be finished. Needs more earth cleared and some rock placed for dissipation.
Slippery Creek	SLI_MAIN_29	UNK_012	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Public	Does Not Apply	Shear 0.6 m drop from apron to stream. Apron beginning to become undercut. Recommend erosion protection is installed.
Slippery Creek	SLI_MAIN_30	UNK_013	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	
Slippery Creek	SLI_MAIN_31	UNK_014	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	
Slippery Creek	SLI_MAIN_32	UNK_015	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	
Slippery Creek	SLI_MAIN_28	UNK_016	Outlet point (no structure)	None	Not in GIS	None	None	Public	Does Not Apply	Approx. 3 m^2 of rock after apron down bank to stream. No upstream habitat
Slippery Creek	SLI_MAIN_15	UNK_017	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Private	Swimmers	Outlet for culvert that connects to tributary. Rock down bank to stream after apron.
Slippery Creek	SLI_MAIN_17	UNK_018	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Erosion in channel from perched culvert.
Hays Stream	HAY_MAIN_5	UNK_031	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Public	Does Not Apply	
Hays Stream	HAY_MAIN_5	UNK_032	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Public	Does Not Apply	Apron consists of rock set in concrete.
Waihoihoi Stream	WAI_TRIB5a_1	UNK_042	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road.
Waihoihoi Stream	WAI_TRIB5a_2	UNK_043	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road.

Hays Stream	HAY_MAIN_20	UNK_051	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Private	Climbers	Small outlet at base of dam wall. Concrete dam with 1.75 m wide constricted flow at top of waterfall. 9 m wetted width at base of waterfall onto concrete apron. Scoring into concrete apron 0.4 m in places. 0.7 m drop height from concrete apron to channel of stream.
Slippery Creek	SLI_MAIN_39	UNK_054	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Severe	Private	Does Not Apply	Severe erosion around outlet pipe. Undercutting of pipe. Bank slumping behind the pipe.
Slippery Creek	SLI_MAIN_39	UNK_055	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Severe	Private	Does Not Apply	Severe erosion around outlet pipe. Undercutting of pipe and bank on the road side.
Hays Stream	HAY_MAIN_29	UNK_068	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Public	Does Not Apply	Major undercutting 1.5 m under apron. Potential for structural failure. Erosion does not appear to be caused by outlet flow but from channel.
Hays Stream	HAY_MAIN_29	UNK_070	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Public	Does Not Apply	Apron not discernible. Very cloudy water. No upstream habitat.
Hays Stream	HAY_MAIN_35	UNK_075	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Severe	Council	Does Not Apply	Major erosion under pipe, photos do not show it very well. Water is creating a deep incised channel that flows down to the stream.
Hays Stream	HAY_MAIN_35	UNK_076	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Council	Swimmers	Structure for three culverts under road. Concrete apron.
Hays Stream	HAY_MAIN_36	UNK_077	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Council	Does Not Apply	Headwall and wingwall. No Apron. 3 large culverts under gravel watercare road.
Hays Stream	HAY_TRIB5_5	UNK_089	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Bank slumping on TLB in addition to bank scouring on both banks. Erosion is a combined result from the confluence of 2 culverts.
Hays Stream	HAY_TRIB5_6	UNK_092	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Culvert under farm crossing. Down pipe placed at outlet but overflowing. Scouring below outlet.
Hays Stream	HAY_TRIB5_5	UNK_093	Outlet point (no structure)	None	Not in GIS	Structural	Moderate	Private	Climbers	Corrugated iron placed under pipe as dissipation structure. Funnelling water into TRB causing erosion. Bank has scoured out, slumped and is now scouring again. Drop at pipe and at base of 'apron'.

Slippery Creek	SLI_TRIB3_10	UNK_106	Outlet point (no structure)	None	Not in GIS	Structural	Moderate	Private	Swimmers	Concrete chute at outlet of farm pond. Chute broken in half and offset to one side. Scour 0.5 m deep with sediment deposition immediately downstream at lower pond.
Hays Stream	HAY_TRIB2_1	UNK_122	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Flow bypassing culvert causing scouring under fenced area.
Hays Stream	HAY_TRIB2_2	UNK_125	Inlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Culvert under farm crossing. Bank eroded above and around inlet.
Hays Stream	HAY_MAIN_9	UNK_130	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	
Hays Stream	HAY_MAIN_15	UNK_131	Outlet point (no structure)	None	Not in GIS	Erosion Protection	Moderate	Public	Does Not Apply	Moderate erosion and slumping on TRB after outlet. Unsure if upstream habitat.
Slippery Creek	SLI_TRIB9_2	UNK_132	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under stream crossing.
Slippery Creek	SLI_TRIB9_2	UNK_133	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Slight	Public	Does Not Apply	
Slippery Creek	SLI_TRIB9_4	UNK_134	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Rocks extend into channel.
Slippery Creek	SLI_TRIB9_5	UNK_135	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under stream crossing.
Slippery Creek	SLI_TRIB9a_1	UNK_136	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Public	Swimmers	Wetted margin. Access for swimmers in high flows.
Slippery Creek	SLI_TRIB9a_2	UNK_137	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Public	None	
Slippery Creek	SLI_TRIB9_1	UNK_138	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Slight	Public	Does Not Apply	Outlet from pipe asset 1132863, fitting not in GIS.
Slippery Creek	SLI_TRIB9_1	UNK_139	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	Slight	Public	Does Not Apply	Concreted rock down bank to stream. Has started to come away from apron.
Waihoihoi Stream	WAI_TRIB5b_1	UNK_140	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Erosion Protection	Moderate	Private	None	Small inlet for private driveway. Very small concrete apron extending 30cm into the stream. Some erosion on TRB side probably due to high flows.
Waihoihoi Stream	WAI_MAIN_10	UNK_176	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Patching	None	Public	Does Not Apply	Headwall and wingwall. No Apron. Box culvert under road. Some erosion on wingwalls.
Waihoihoi Stream	WAI_MAIN_11	UNK_177	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Patching	Slight	Public	Does Not Apply	Headwall and wingwall. No Apron. Box culvert under road. Some erosion on wingwalls.
Waihoihoi Stream	WAI_TRIB5_13	UNK_178	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road.

Waihoihoi Stream	WAI_TRIB 5_14	UNK_1 81	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road.
Waihoihoi Stream	WAI_TRIB 7_3	UNK_1 84	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road. Difficult to see pipe, likely half full.
Waihoihoi Stream	WAI_TRIB 7a_1	UNK_1 85	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road. Pipe is partly sunken into bed and has a high sediment load.
Waihoihoi Stream	WAI_TRIB 7a_2	UNK_1 86	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road. Inlet embedded into channel or high accumulated sediment
Waihoihoi Stream	WAI_MAIN _18	UNK_2 16	Outlet point (no structure)	None	Not in GIS	None	Slight	Public	Climbers	Culvert under road. Concrete apron extension of culvert. Remnants of concrete structure on banks.
Waihoihoi Stream	WAI_MAIN _19	UNK_2 17	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road.
Waihoihoi Stream	WAI_TRIB 7_4	UNK_2 18	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road.
Slippery Creek	SLI_TRIB1 0_6	UNK_2 35	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	Slight	Private	Climbers	Structure has opening diameter of 700 mm but pipe actually 1050 mm.
Symonds Stream	SYM_MAI N_19	UNK_2 37	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Patching	None	Public	Swimmers	Concrete apron breaking up but in places. Gabions slumping a little. Rock riprap at toe of gabions. Head wall concrete and masonry block is breaking up but in places.
Symonds Stream	SYM_MAI N_20	UNK_2 38	Standard Inlet (Headwall and Wingwalls)	Masonry Block	Not in GIS	None	None	Public	Does Not Apply	Headwall and wingwall. No Apron.
Waihoihoi Stream	WAI_TRIB 2_4	UNK_2 49	Outlet point (no structure)	None	Not in GIS	None	Slight	Public	Does Not Apply	Concrete apron only at toe of road culvert. Rough surface. No upstream habitat. Drop height of 2.5 m between apron and culvert.
Waihoihoi Stream	WAI_TRIB 2_4	UNK_2 50	Outlet point (no structure)	None	Not in GIS	Erosion Protection	Moderate	Private	Does Not Apply	Culvert under farm crossing. Undercut bank below culvert.
Waihoihoi Stream	WAI_TRIB 2bl_4	UNK_2 78	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road. Can hear water inside but no flow coming out of pipe. Can see small trickle underneath pipe.
Waihoihoi Stream	WAI_TRIB 2bl_5	UNK_2 79	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under driveway alongside road.
Waihoihoi Stream	WAI_TRIB 2bl_5	UNK_2 80	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under driveway alongside road.
Waihoihoi Stream	WAI_TRIB 2bl_5	UNK_2 81	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under driveway alongside road.

Waihoihoi Stream	WAI_TRIB 2bl_6	UNK_2 82	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under driveway alongside road.
Waihoihoi Stream	WAI_TRIB 2bl_6	UNK_2 83	Inlet point (no structure)	None	Not in GIS	Does Not Apply	Slight	Public	Does Not Apply	Culvert under driveway alongside road. Some erosion on TRB side of pipe.
Waihoihoi Stream	WAI_TRIB 2bl_7	UNK_2 86	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Council	Does Not Apply	Culvert under driveway.
Waihoihoi Stream	WAI_TRIB 2bl_7	UNK_2 87	Standard Inlet (Headwall and Wingwalls)	Masonry Block	Not in GIS	None	None	Public	Does Not Apply	Headwall and wingwall. No Apron. Culvert under driveway.
Waihoihoi Stream	WAI_TRIB 2bl_8	UNK_2 88	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Public	Does Not Apply	Headwall and wingwall. No Apron.
Waihoihoi Stream	WAI_TRIB 2bl_8	UNK_2 89	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under driveway.
Waihoihoi Stream	WAI_TRIB 2bl_8	UNK_2 90	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under driveway.
Waihoihoi Stream	WAI_TRIB 2_14	UNK_3 07	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Public	Does Not Apply	Headwall and wingwall. No Apron. Culvert under Road. Structure looks relatively new, leads to small wetland area.
Waihoihoi Stream	WAI_TRIB 2_15	UNK_3 09	Outlet point (no structure)	None	Not in GIS	None	None	Private	Climbers	Concrete apron 0.7 m above channel. Rock dissipating structure below.
Waihoihoi Stream	WAI_TRIB 2_15	UNK_3 10	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Public	Does Not Apply	Headwall and wingwall. No Apron.
Hays Stream	HAY_MAI N_50	UNK_3 48	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Public	None	Culvert under road.
Hays Stream	HAY_TRIB 11_1	UNK_3 60	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	Replaceme nt	Slight	Private	Climbers	Measurements are only estimates as couldn't get close to outlet. Looks as if apron has fallen down and broken into two. High flow at time of survey due to rain.
Hays Stream	HAY_TRIB 12_1	UNK_3 61	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road.
Hays Stream	HAY_TRIB 12_1	UNK_3 62	Standard Inlet (Headwall and Wingwalls)	Concrete	Not in GIS	Patching	Slight	Private	Does Not Apply	Headwall and wingwall. No Apron. Culvert under road, Wooded boards on either side of inlet could do with some patching, one board has fallen down.
Symonds Stream	SYM_TRIB 1all_2	UNK_3 64	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Public	None	Farm culvert under road.

Symonds Stream	SYM_TRIB 1all_2	UNK_3 65	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Public	None	Outlet for two culverts. Inlets unknown, upstream habitat unknown.
Symonds Stream	SYM_TRIB 1all_2	UNK_3 66	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Culvert under farm crossing. Undercut bank below culvert.
Symonds Stream	SYM_TRIB 2_4	UNK_3 72	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road. Debris surrounds outlet and difficult to see.
Symonds Stream	SYM_TRIB 2_5	UNK_3 73	Inlet point (no structure)	None	Not in GIS	Does Not Apply	Slight	Public	Does Not Apply	Culvert under road. Build up of debris and rubbish.
Symonds Stream	SYM_TRIB 2_6	UNK_3 74	Standard Outlet (Headwall and Wingwalls)	Masonry Block	Not in GIS	Vegetation Clearance	None	Public	Swimmers	Unsure if dissipating structure present due to mat of willow roots. Outlet almost completely obstructed by willow roots.
Symonds Stream	SYM_TRIB 2_7	UNK_3 75	Standard Inlet (Headwall and Wingwalls)	Masonry Block	Not in GIS	None	None	Public	Does Not Apply	Headwall and wingwall. No Apron. Culvert under road. Flood debris 2 m high. Resident said flooding was over road from last weeks rain and paddock nearest to road was under water.
Symonds Stream	SYM_TRIB 2_7	UNK_3 76	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Culvert under farm crossing. Undercut outlet and erosion on banks.
Symonds Stream	SYM_TRIB 2_10	UNK_3 79	Outlet point (no structure)	None	Not in GIS	Erosion Protection	Severe	Private	Does Not Apply	Culvert under farm crossing. Erosion below outlet. Undercut below outlet approx. 0.2 m. Fish barrier recorded at pipe asset.
Symonds Stream	SYM_TRIB 2_10	UNK_3 80	Outlet point (no structure)	None	Not in GIS	Erosion Protection	Severe	Private	Does Not Apply	Culvert under farm crossing. Erosion below outlet. Undercut below outlet approx. 1 m. Fish barrier recorded at pipe asset.
Symonds Stream	SYM_TRIB 2_11	UNK_3 81	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Slight	Public	Does Not Apply	Culvert under road. Bank undercut slightly below outlet.
Symonds Stream	SYM_TRIB 2_8	UNK_3 83	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Culvert under farm crossing. Erosion below outlet. Undercut below outlet approx. 0.2 m.
Symonds Stream	SYM_TRIB 2_11	UNK_3 85	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Outlet perched above channel and undercut which may compromise structural integrity in future. Scouring below outlet.
Symonds Stream	SYM_TRIB 2_12	UNK_3 86	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road. Vines across inlet. Culvert above stream bed 0.15 m.
Symonds Stream	SYM_MAI N_22	UNK_4 08	Outlet point (no structure)	None	Not in GIS	Patching	None	Private	Swimmers	Concrete apron broken and perched. Very high velocity over apron at time of survey.

Hays Stream	HAY_TRIB 6c_10	UNK_4 14	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Major erosion just downstream from fallen tree and old culvert has broken away; next drop is 1.5 m down to the stream bed, actively eroding.
Hays Stream	HAY_TRIB 6_7	UNK_4 51	Outlet point (no structure)	None	Not Located	Does Not Apply	Moderate	Private	Does Not Apply	Could not locate/survey. Willow in instream causing overflow.
Hays Stream	HAY_TRIB 6j_3	UNK_4 73	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Culvert under farm crossing. Scoured deep pool below outlet.
Hays Stream	HAY_TRIB 6j_3	UNK_4 74	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Culvert under farm crossing. Scoured deep pool below outlet.
Hays Stream	HAY_TRIB 6j_7	UNK_4 81	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Culvert under farm crossing. Scouring and erosion in deep pool below.
Hays Stream	HAY_TRIB 6f_1	UNK_4 88	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Public	Does Not Apply	Culvert under road.
Hays Stream	HAY_TRIB 6f_1	UNK_4 89	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road.
Slippery Creek	SLI_TRIB1 0_8	UNK_5 09	Outlet point (no structure)	None	Not in GIS	None	Slight	Private	Climbers	Plastic mat as dissipating structure/fish passage. Teared in some parts. Areas of low flow but steep gradient.
Slippery Creek	SLI_TRIB1 0_8	UNK_5 10	Outlet point (no structure)	None	Not in GIS	None	Slight	Private	Climbers	Plastic mat as dissipating structure/fish passage. Teared in some parts. Areas of low flow but steep gradient.
Slippery Creek	SLI_TRIB1 _1	UNK_5 13	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Slight	Public	Does Not Apply	Culvert under road. Slight scour on TRB 5 m along from outlet. Slight down cutting.
Slippery Creek	SLI_TRIB1 _2	UNK_5 14	Inlet point (no structure)	None	Not in GIS	Does Not Apply	Slight	Public	Does Not Apply	Slight erosion of bank above outlet towards road. Minor debris jam from flood flows.
Hays Stream	HAY_TRIB 1_3	UNK_5 31	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under road.
Hays Stream	HAY_TRIB 1_4	UNK_5 33	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Public	Does Not Apply	Headwall and wingwall. No Apron. Resident said in past there were flooding problems before road. Since structure no issues.
Slippery Creek	SLI_TRIB2 _2	UNK_5 50	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Culvert under farm crossing draining from pond. Historic apron sitting above channel and very cracked. No upstream habitat.
Waihoihoi Stream	WAI_TRIB 1_10	UNK_5 53	Standard Outlet (Headwall and Wingwalls)	Concrete	Not in GIS	None	None	Private	Climbers	Outlet under bridge for driveway. Large apron with 0.5m drop. Water flows underneath but likely same drop height on other side of bridge. Water depth in stream below 0.2 m.

Waihoihoi Stream	WAI_TRIB 1_7	UNK_5 69	Inlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Culvert under rail crossing. Extends onto private land.
Hays Stream	HAY_TRIB 6el_1	UNK_5 71	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Erosion below outlet. Concrete slabs on sides of channel potentially broken apron or makeshift wingwalls.
Hays Stream	HAY_TRIB 6e_6	UNK_5 73	Inlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Moderate erosion on TRB side of inlet, thought to be due to flooding.
Hays Stream	HAY_TRIB 4_3	UNK_5 78	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Severe	Private	Does Not Apply	Recent landslide into stream from upper bank where perched pipes are located, pile of loose sediment on the stream bed. Bank is 2.8 m in height.
Hays Stream	HAY_TRIB 6fl_1	UNK_5 79	Outlet point (no structure)	None	Not in GIS	Does Not Apply	None	Public	Does Not Apply	Outlet under gravel road. High sediment build up downstream from blow out on other side of the road.
Hays Stream	HAY_TRIB 6fl_2	UNK_5 81	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Severe	Private	Does Not Apply	Outlet from farm crossing. Severe erosion from undercutting has caused major land slips into channel. Bank is undercut 0.6 m from where original edge was.
Hays Stream	HAY_TRIB 6fl_3	UNK_5 82	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Some erosion under outlet.
Symonds Stream	SYM_MAI N_FORK2 _TRIB2_1	UNK_5 99	Inlet point (no structure)	None	Not Located	Does Not Apply	Does Not Apply	Private	Does Not Apply	Could not locate/survey.
Symonds Stream	SYM_MAI N_FORK2 _10	UNK_6 00	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Outlet from unmarked tributary from North. Scouring around base of pool below outlet and undercutting.
Hays Stream	HAY_TRIB 6i_4	UNK_6 06	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Scouring below outlet as drop of 0.7 m. Upstream habitat is a farm pond.
Hays stream	HAY_TRIB 6k_1	UNK_6 07	Outlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Scouring in pool below. Large rocks and boulders below outlet.
Hays stream	HAY_TRIB 6k_4	UNK_6 10	Inlet point (no structure)	None	Not in GIS	Does Not Apply	Moderate	Private	Does Not Apply	Undercut bank and erosion on TLB. Bedload 50% capacity with sediment.
Hays Stream	HAY_TRIB 12_4	UNK_6 20	Outlet point (no structure)	None	Not in GIS	Erosion Protection	Moderate	Private	Does Not Apply	Scouring below outlet. Rocks as dissipating structure. Fish barrier recorded at pipe asset.